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CONTENTS

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PART I. OFFICIAL

PAGE

1. **Officers of the Twenty-sixth Congress** .. .. I. 3
2. **Officers of the Indian Science Congress Association for 1938-39** .. .. I. 6
3. **Local Reception Committee** .. .. .. I. 12
4. **General** .. .. I. 15
5. **Opening Proceedings** .. .. I. 21
6. **Official** .. .. I. 25
    - (A) Delegates from the British Association for the Advancement of Science .. .. .. I. 25
    - (B) Delegates from Universities, Learned Societies, Colleges, States and Government Departments in India .. .. I. 25
    - (C) Financial Arrangements for the Twenty-sixth Session .. .. I. 27
    - (D) Meetings of the General Committee, the Council and the Executive Committee of the Indian Science Congress Association .. .. .. I. 28
    - (E) Resolutions adopted by Sections .. .. I. 39
    - (F) Rules and Regulations .. .. .. I. 40
    - (G) Statement of Accounts .. .. .. I. 49

PART II. PRESIDENTIAL ADDRESSES

Plenary Meeting.

Presidential Address: By Congress President, Professor J. C. Ghosh, D.Sc., F.N.I. .. .. .. II. 1

Section of Mathematics and Physics.

Presidential Address: The Earth's Magnetism and the Upper Atmosphere. By K. R. Ramanathan, M.A., D.Sc., F.N.I. .. .. II. 19

Section of Chemistry.

Presidential Address: Analogy among Chemical Elements and Radicles. By P. B. Sarkar, Dr. es Sc., A.I.C., F.N.I. II. 45

Section of Geology.

PAGE

Presidential Address: Conservation of India's Mineral Wealth. By S. K. Roy, B.Sc., Ph.D., F.G.S. .. .. II. 65

Section of Geography and Geodesy.

Presidential Address: The Geographical Personality of India. By N. Subrahmanyam, M.A., L.T., F.R.G.S. .. II. 99

Section of Botany.

Presidential Address: Indian Forest Mycology with special reference to Forest Pathology. By K. D. Bagchee, D.Sc., D.I.C., F.N.I. .. .. .. II. 141

Section of Zoology.

Presidential Address: Batrachians and their Environment. By C. R. Narayan Rao, M.A. .. .. .. II. 169

Section of Anthropology.

Presidential Address: Tribal Culture and Acculturation. By D. N. Majumdar, M.A., Ph.D., F.R.A.I. .. .. II. 179

Section of Medical and Veterinary Research.

Presidential Address: A Brief Account of the History of Pathology. By Rao Bahadur T. S. Tirumurti, B.A., M.B. & C.M., D.T.M. & H., F.N.I. .. .. .. II. 225

Section of Agriculture.

Presidential Address: Insects and their Rôle in Indian Agriculture. By Rao Sahib T. V. Ramakrishna Ayyar, B.A., Ph.D., F.Z.S. .. .. II. 271

Section of Physiology.

Presidential Address: Physiological Research in India. By N. M. Basu, M.A. .. .. II. 317

Section of Psychology.

Presidential Address: Dynamic Structure of the Human Personality. By H. P. Maiti, M.A. .. .. II. 341

PART III. ABSTRACTS OF PAPERS

LIST OF PAPERS.

*(Papers marked with an * are recorded by title only.)*

Section of Mathematics and Physics.

PURE MATHEMATICS.

*1. The application of group-characters for the determination of normal modes. By R. Vaidyanathaswamy .. III. 1

PAGE

2. Further contributions to the theory of non-linear integral equations. By M. Raziuddin Siddiqi .. .. III. 1
3. On certain self-reciprocal functions. By S. C. Dhar .. III. 2
4. Some infinite series involving the product of Bessel functions and Weber's parabolic cylinder functions. By R. S. Varma .. .. III. 2
5. A pair of functions which are Hankel transforms of each other. By R. S. Varma .. .. .. III. 2
6. On the axial lines of a quadric. By C. V. H. Rao .. III. 2
7. On integral functions of finite order. By S. M. Shah .. III. 3
8. On certain expansions involving Bessel functions. By S. C. Mitra .. .. III. 3
9. On sphero-tangential equation of a surface. By D. N. Sen and V. Rangachariar .. .. .. III. 4
10. Generalizations on partial fractions in determinantal forms. By D. N. Sen and R. Mahanty .. .. III. 4
11. On an interpolation formula for triple integration. By P. N. Das Gupta .. .. III. 4
12. On a pair of factorable recurrents. By S. C. Chakrabarti.. III. 4
13. On an Algebraic identity and a unit recurrent. By S. C. Chakravarti .. .. III. 5

APPLIED MATHEMATICS AND STATICS.

14. Some boundary value problems of the theory of elasticity. By Bibhutibhusan Sen .. .. .. III. 6
15. Some problems of finite strain. By B. R. Seth .. III. 6
16. Uniform motion of a sphere or a cylinder through a viscous liquid. By B. R. Seth .. .. .. III. 6
17. A note on grid sampling. By P. C. Mahalanobis .. III. 7
18. The distribution of the studentised D^2 statistic appropriate to any pair out of a given set of k equidispersional populations distinct in sets of means. By R. C. Bose and S. N. Roy .. .. III. 7
19. On the completely orthogonalized Hyper-Graeco Latin Square. By R. C. Bose .. .. .. III. 8
20. On the generalized interaction in a $s \times s \times s \times \ldots\ldots (= s^n)$ factorial arrangement, where s is a prime or a power of a prime. By R. C. Bose and K. Kishen .. III. 9
21. Tables of confidence intervals for the median in samples from any continuous population. By K. Raghavan Nair .. .. III. 9
22. The use of median statistic in tests by randomization. By K. Raghavan Nair .. .. .. III. 9

ASTRONOMY, ASTROPHYSICS AND ATOMIC PHYSICS.

23. Some photographs of regions in the Milky Way, taken with a short focus camera. By T. P. Bhaskara Shastri .. III. 10
24. A survey of stars with large proper motion in the Hyderabad Astrographic Zones. By T. P. Bhaskara Shastri .. III. 10

PAGE

25. Levi-Civita's potential function for two bodies. By Sir Shah Sulaiman .. .. III. 10
26. The equilibrium between neutrons, protons, and electrons. By D. S. Kothari and B. N. Singh .. .. III. 11
27. The arms of a spiral nebula. By A. C. Banerji, Nazimuddin and P. L. Bhatnagar .. .. III. 11
28. On the gravitational influence of radiation on radiation. By N. R. Sen .. .. III. 12
29. Angular distributions of emitted particles in nuclear reactions. By P. L. Kapur .. .. .. III. 12
30. Partial entry of particles through potential barriers. By P. L. Kapur .. .. III. 13
31. Entropy of Fermi-Dirac gas. By F. C. Auluck .. III. 13
32. The internal constitution of white dwarf stars and the planets. By F. C. Auluck .. .. .. III. 13

PHYSICS OF THE ATMOSPHERE AND METEOROLOGY.

33. The Fringe of the outer atmosphere. By S. K. Mitra .. III. 13
34. On the intensity of the ionization in the earth's atmosphere. By A. C. Banerji and P. L. Bhatnagar .. .. III. 14
35. Spectroscopic determination of the amount of ozone in the atmosphere over Bombay. By M. W. Chiplonkar .. III. 14
36. On the brightness of the zenith sky during twilight on clear evenings and the variation of temperature with height in the upper atmosphere. By M. W. Chiplonkar .. III. 15
37. Relationship between upper wind velocity and temperature. By S. K. Banerji .. .. III. 15
38. A study of stability of atmospheric strata. By S. L. Malurkar .. .. III. 16
39. Changes of atmospheric electric potential gradient associated with monsoon rains in Bombay. By A. R. Pillai III. 17
40. Rainfall in the Punjab. By J. B. Seth .. .. III. 17
41. Experimental aeroplane soundings with meteorograph over Karachi. By P. R. Krishna Rao .. .. III. 17
42. Diurnal variation in the temperature and humidity distribution up to 3 km. over Karachi. By P. R. Krishna Rao .. .. III. 17
43. Fog at Karachi Air Port, Drigh Road. By P. R. Krishna Rao .. .. III. 18
44. On forecasting of weather over south Bengal during the nor'wester season, mid-March to mid-May. By A. K. Roy .. .. III. 18
45. The thermal structure of the air layers near the ground at night during clear weather in relation to other meteorological factors. By L. A. Ramdas .. .. III. 19
46. Vertical currents in the first few kilometers over Poona and their possible effect on the measures of upper winds made by pilot balloons assumed to rise at a known constant rate. By K. P. Ramakrishnan .. .. III. 19
47. Inter-diurnal variability of pressure and temperature at different levels over Agra in N. India during the period November to April. By M. W. Chiplonkar .. III. 19

SPECTROSCOPY.

PAGE

48. On the identification of the Sun-spot line at λ 6708A. By S. Datta and G. Karmakar .. .. .. III. 20
49. Note on a change in the transition probability of sodium atoms in absorption. By S. Datta and G. Karmakar.. III. 20
50. The higher spark-spectra of iodine I(VI) and I(VII). By R. Sanjivarao and S. G. Krishnamurty .. .. III. 21
51. The higher spark-spectra of iodine I(V). By S. G. Krishnamurty and R. Sanjivarao .. .. .. III. 21
52. Continuous spectrum of helium. By P. K. Kichlu .. III. 21
53. Absorption spectrum of cadmium by the excitation of inner electrons. By P. K. Kichlu and B. M. Anand .. III. 21
54. Absorption of bismuth vapour between 600 Å and 900 Å. By P. K. Kichlu and B. M. Anand .. .. III. 21
55. Absorption of active-nitrogen in the Schumann region. By Mela Ram, P. N. Kalia and B. M. Anand .. .. III. 22
56. Production of hydrogen Lyman series. By B. M. Anand .. III. 22
57. Production of the spectra of antimony in a hot hollow cathode. By Tirath Ram and Tara Chand .. III. 22
58. Predissociations in the bands of CuCl. By R. K. Asundi and Asrar Husain .. .. III. 22
59. The flame spectrum of copper bromide. By R. K. Asundi and M. M. Aziz .. .. III. 23
60. Flame spectra of some salts of alkaline earths. By B. K. Vaidya .. .. III. 23
61. Variation of the relative infra-red content of the solar radiations at Bombay. By N. R. Tawde, Y. G. Naik and V. D. Dessai .. .. III. 23
62. First positive bands in high temperature arc. By N. R. Tawde and V. D. Desai .. .. .. III. 23

ELECTRIC DISCHARGE THROUGH GASES AND RELATED PHENOMENA.

63. The ultra-high frequency dielectric constant and electrical conductivity of ionized air in a discharge tube. By S. R. Khastgir and Shah Md. Fazlor Rahman .. .. III. 24
64. The dielectric constant and electrical conductivity of gases and vapours ionized by X-rays at ultra-high radio frequency. By S. R. Khastgir and Shah Md. Fazlor Rahman .. .. III. 24
65. 'Chemical clean up' in a positive ray tube. By V. T. Chiplonkar .. .. III. 25
66. Localisation of discharge in a positive ray tube. By V. T. Chiplonkar .. .. III. 25
67. Ring deposits due to bombardment by positive rays. By V. T. Chiplonkar .. .. III. 26
68. A new type of Doppler effect in positive rays of hydrogen. By B. Dasannacharya and G. K. Das .. .. III. 26
69. The Doppler effect with positive rays of mercury. By B. Dasannacharya and G. K. Das .. .. III. 26
70. The counting in Geiger point counter. By B. Dasannacharya and A. C. Seth .. .. .. III. 27
71. Mercury arc lamps of exceedingly long life and made of soft glass. By C. Dakshinamurti and B. Dasannacharya .. III. 27

RAMAN EFFECT, ASSOCIATION IN LIQUIDS AND RELATED SUBJECTS.

PAGE

72. Raman spectra of camphor in different solvents. By B. M. Anand and Narain Singh .. .. .. III. 27
73. Association in formic acid. By P. Koteswaram .. III. 27
74. Continuous spectrum in Raman effect. By P. Koteswaram III. 28
75. Raman spectra and the structure of PCl_5 and $SbCl_5$. By T. Venkatarayudu .. .. III. 28
76. Influence of a fluorescent dyestuff molecule on the polarization of fluorescence of another dyestuff in solution. By S. M. Mitra .. .. III. 28
77. On the influence of foreign substances on the absorption of the dyestuffs in solution. By S. M. Mitra.. .. III. 29
78. Dielectric constants of certain liquids with special reference to dispersion at audio frequencies. By H. R. Sarna .. III. 29

TECHNICAL PHYSICS AND GENERAL PROPERTIES OF MATTER.

79. The effect of storage at different relative humidities on the strength and colour of cotton. By N. Ahmad and A. N. Gulati .. .. III. 29
80. A self-recording apparatus for determination of fibre-strength. By S. S. Sukthankar, N. Ahmad and H. Nawkal .. III. 30
81. Natural weathering of paints and some considerations entering the technique of testing their durability. By Lal C. Verman, N. Ghatak and H. Trivedi.. .. III. 30
82. Accelerated weathering of paints and the development of a weatherometer suitable for tropical climates. By Lal C. Verman, H. Trivedi and N. Ghatak .. .. III. 31
83. Use of Indian bentonite in building materials. By A. D. Banerji, C. A. Khan and Lal C. Verman .. .. III. 31
84. Automatic cell-testing device. By G. D. Joglekar and Lal C. Verman .. .. III. 31
85. Thermal endurance of electric lamp glass bulbs. By S. Mujtaba Karim, Lal C. Verman and S. V. Anantakrishnan .. .. III. 32
86. The maximum efficiency of tungsten filament electric lamps. By D. R. Bhawalkar .. .. III. 32
87. The use of vegetable oils as fuels for internal combustion engines. By H. D. Chowdhury, S. N. Mukerji, A. N. Kapoor and J. S. Aggarwal .. .. .. III. 32
88. Some experiments on the thermal repulsion of particles. By L. A. Ramdas and S. Y. Joglekar .. .. III. 33
89. A magnetic investigation of the photohalides of silver. By Parmanand Sharma and L. N. Srivastava .. III. 33
90. Thermal properties of films of liquid Helium II. By M. Zakiuddin .. .. III. 33
91. Transfer of liquid helium II. By M. Zakiuddin .. III. 34
92. On the specific heat of lac. By G. N. Bhattacharya .. III. 34
93. The law of ellipticity for the minor axis in a Foucault's pendulum. By B. Dasannacharya and B. S. Gautam .. III. 34
94. Optical silvering on glass by the chemical method and the critical rôle of the extent of surface. By B. Dasannacharya and A. C. Seth .. .. .. III. 35

Section of Chemistry.

INORGANIC CHEMISTRY.

PAGE
1. Complex compounds of biguanide with tervalent metals, cobalt phenyl-biguanidine and its salts. By P. R. Ray and H. Bhattacharya .. .. .. III. 37
2. Compounds of biguanide with bivalent metals, copper biguanidine and its salts. By P. R. Ray and P. N. Bagchi .. .. III. 37
3. Chromium chromates. By V. T. Athavale and S. K. K. Jatkar .. .. III. 37
4. Experiments on resolution of co-ordinated inorganic compounds. Part III. Co-ordinated copper compounds with propylene diamine. By P. Neogi and K. L. Mandal III. 37
5. Resonance reactions. Part II. By P. Neogi and K. L. Mandal .. .. III. 38
6. On the potassium salt of a new borohydrate. By R. C. Ray and P. C. Sinha .. .. III. 38
7. Reaction of sodium thiosulphate and organic acids in the solid state. By L. N. Srivastava .. .. III. 38
8. Electrolysis of aqueous magnesium chloride solutions. By S. S. Joshi and Victor Caldwell .. .. III. 39
9. Behaviour of nitrogen peroxide under electric discharge. Anomalous pressure reversal effect. By S. S. Joshi and K. S. Visvanathan .. .. .. III. 39
10. Decomposition of phosphine under electrical discharge. By S. S. Joshi and T. D. Bhaskar .. .. III. 39
11. Electrolytic formation of calcium chlorate from aqueous calcium chloride by electrolysis. By S. S. Joshi and Gopal Tripathi .. .. III. 40
12. Electrolytic formation of sodium chlorite from brine mixtures. By S. S. Joshi and K. Srinivasan .. .. III. 40
13. Synthesis of potassium permanganate from Indian raw materials. By S. S. Joshi and L. S. Chandrakant .. III. 40
14. Studies in active nitrogen. Part II. By S. S. Joshi and A. Purushotham .. .. III. 41
15. Studies in active nitrogen. Part III. By S. S. Joshi and A. Purushotham .. .. III. 42
16. Studies in active nitrogen. Part IV. By A. Purushotham III. 42
17. Studies in active nitrogen. Part V. Wall effect. By A. Purushotham .. .. III. 43

PHYSICAL CHEMISTRY.

18. Magnetism and molecular constitution of some chromium compounds. By S. S. Bhatnagar, Brahm Prakash and Abdul Hamid .. .. III. 43
19. Diamagnetic susceptibility of chlorohydrate. By M. Qureshi and M. A. Hai .. .. .. III. 44
20. Magnetic susceptibilities of solutions of sodium and potassium nitrate. By S. P. Ranganatham and M. Qureshi.. III. 44
21. Magneto-chemical investigation of the photohalides of silver. By L. N. Srivastava and Parmanand Sharma .. III. 45
22. Electrochemistry of resin solutions. By S. R. Palit .. III. 45

PAGE

23. Temperature coefficient of conductivity of an aq. solution of iodic acid. By M. R. Nayar.. .. .. III. 45
24. The temperature coefficients of electrical conductivity and viscosity of aqueous mercuric chloride at different temperatures. By S. S. Joshi and D. N. Solanki .. III. 45
25. Formation of complex ions in aqueous silver nitrate in the presence of sucrose. By S. S. Joshi and Sankaranand Mukherji .. .. III. 47
26. Studies in the hydrolysis of esters. Part I. By S. V. Anantakrishnan and T. N. Krishnamurthi.. .. III. 47
27. Theory of electro-deposition of chromium. By S. Husain.. III. 47
28. Molybdenum electrode. By C. T. Abichandani and S. K. K. Jatkar .. .. III. 47
29. Dissociation constants of hydroxy-benzoic acids and gallic acid. By C. T. Abichandani and S. K. K. Jatkar .. III. 48
30. Dissociation constants of catehol, resorcinol, hydro-quinone, pyrogallol and phloroglucinol. By C. T. Abichandani and S. K. K. Jatkar .. .. .. III. 48
31. Dissociation constants to tannic acids. By S. K. K. Jatkar and S. R. Sunthankar .. .. .. III. 48
32. Effect of inorganic colloids on the electro-deposition of nickel on iron. By V. S. Puri and F. R. M. Alvi .. III. 48
33. The behaviour of organic solids on the surface of water. By G. V. L. Narasimha Murty.. .. .. III. 48
34. The nature of the potential barrier at surfaces of solutions of capillary-active electrolytes. By K. S. Gururaja Dass.. III. 49
35. Adsorption and retention of helium by cocoanut shell charcoal. By P. R. Subbaraman and K. R. Krishnaswami .. .. III. 49
36. The relative activities of samples of adsorbent charcoal as determined by different methods. By M. V. C. Sastri and K. R. Krishnaswami .. .. .. III. 49
37. Influence of electric fields on the viscosity of colloids. By S. S. Joshi and V. C. Subbaiah.. .. .. III. 50
38. Studies in bivalent metallic soaps. By S. S. Bhatnagar, P. L. Kapur and A. Hussain .. .. .. III. 51
39. Studies in gels of sodium oleate. By Mata Prasad and K. N. Mathur .. .. III. 51
40. Studies in coagulation and gelation by viscosity and opacity measurements. By Mata Prasad and K. V. Modak .. III. 51
41. The yield value of thixotropic bentonite suspensions. By N. C. Sen Gupta .. .. III. 52
42. A comparison of the properties of 'humic acid' obtained from different sources. By G. C. Esh and S. S. Guha Sircar .. .. III. 52
43. The interaction of silicic acid sol with concentrated alkalis. By B. Chatterjee .. .. III. 52
44. Diffusion analysis of sodium silicate solutions. By R. C. Ray and P. B. Ganguly .. .. .. III. 52
45. Dehydration of fuller's earth. By B. S. Kulkarni and S. K. K. Jatkar .. .. III. 53
46. Photo-reduction of ferric chloride in the presence of acetaldehyde. By Mata Prasad and C. R. Talpade .. III. 53

PAGE

47. Action of light on some organic colouring matters. By C. M. Desai and B. K. Vaidya .. .. .. III. 54
48. Phototropy and photochemical isomerism from the magnetic standpoint. By S. S. Bhatnagar, P. L. Kapur and M. S. Hashmi .. .. III. 54
49. The rates of reaction of *p*-alkyl benzhydryl chlorides with ethyl alcohol. By N. A. Taher .. .. III. 54
50. Studies in the heterogeneous reaction between chromium oxide and potassium permanganate. By Mata Prasad and K. N. Rao .. .. III. 54
51. Activity of different catalysts for vapour phase esterification. By S. K. K. Jatkar and R. K. Valvekar .. .. III. 55
52. Equilibrium between methyl alcohol, acetic acid, methyl acetate and water. By S. K. K. Jatkar and N. G. Gajendragad .. .. III. 55
53. Esterification equilibria in vapour phase. By T. Subramania and S. K. K. Jatkar .. .. .. III. 55
54. Studies in binary mixtures. By S. K. K. Jatkar and (Miss) Nagamani Shama Rao .. .. .. III. 55
55. Adsorption from binary mixtures. By S. K. K. Jatkar and (Miss) Nagamani Shama Rao .. .. III. 56
56. Equilibrium in electrodeless discharge. By R. Krishnan and S. K. K. Jatkar .. .. .. III. 56
57. Behaviour under high tension electric discharge of films of nitrous oxide at liquid air temperature. By S. S. Joshi and G. S. Deshmukh .. .. .. III. 56
58. The hydrogen-chlorine reaction due to electronic activation. By S. S. Joshi and V. Narasimhan .. .. III. 57
59. Viscosity and density of aqueous solutions of sulphuric acid at 35°C. By M. K. Srinivasan and B. Prasad .. III. 58
60. The effect of ageing on the viscosity of shellac-urea solutions in alcohol. By G. N. Bhattacharya and S. Ranganathan .. .. III. 58
61. The space configuration of nitrogen in the 3-covalent state. By B. K. Singh .. .. III. 58
62. An X-ray investigation of the crystals of *o*- and *p*-nitrobenzoic acids. By Mata Prasad, M. R. Kapadia and V. C. Thackar .. .. III. 59
63. Periodic deposits under canal ray discharge. By S. S. Joshi, V. T. Chiplonkar and G. S. Deshmukh .. III. 59
64. Luminescence of phosphorus under electric discharge. By S. S. Joshi and G. K. Nayar .. .. .. III. 59

ORGANIC CHEMISTRY.

65. Condensation of methyl succinic anhydride with phenolic ethers. By P. C. Mitter and Lakshmikanta De .. III. 60
66. Condensation of C-acetyl-methone with aromatic aldehydes. By B. H. Iyer .. .. III. 60
67. Condensation of methyl β-resorcylate with ethyl acetone dicarboxylate and ethyl α-chloroacetoacetate. By S. M. Sethna and R. C. Shah .. .. .. III. 61

PAGE

68. Condensation of protocatechuicaldehyde with malonic acid in the presence of organic bases. Synthesis of caffeic acid. By K. C. Pandya and T. S. Sodhi .. III. 61
69. Condensation of *o*-, *m*- and *p*-nitrobenzaldehydes with malonic acid in the presence of organic bases. By D. B. Singh and K. C. Pandya.. .. .. III. 61
70. Application of H.C. value method in determination of unsaturation. By M. N. Goswami and Sibsankar Chatterjee .. .. III. 62
71. Studies in the naphthalene series. Part III. The synthesis of 2-butyl and 4-butyl-α-naphthols and some mixed diacyl-α-naphthols. By R. D. Desai, Ashraf Ali and H. P. Shroff .. .. III. 62
72. Studies in the naphthalene series. Part IV. Synthesis of trans-decahydro-naphthalene-2-carboxy-3-acetic acid. By Nazir Ahmad, R. D. Desai and G. S. Sahariya .. III. 62
73. Studies in the Friedel-Crafts reaction. Part V. The action of acid chlorides and anhydrides on orcinol and resorcinol derivatives. By R. D. Desai and (Miss) V. M. Vakil .. .. III. 62
74. Studies in cyclohexane series. Part IV. The synthesis of 4-methylcyclohexane 1 : 1-dicarboxylic acid and 3-methylcyclohexane-1 : 1-dicarboxylic acids. By R. D. Desai, R. F. Hunter and G. S. Sahariya .. .. III. 63
75. Studies in the cyclohexane series. Part V. Synthesis of 2-methyl-, 3-methyl- and 4-methylcyclohexane-1-carboxy-1-α-benzylacetic acids. By R. D. Desai, R. F. Hunter and G. S. Sahariya .. .. III. 63
76. Studies in 2-naphthyl chromones. By B. G. S. Acharya and T. S. Wheeler .. .. III. 63
77. 2-naphthylchromones. By V. V. Virkar and T. S. Wheeler III. 63
78. Ring closure of αγ-diarylbutyric acids. By M. Samiulla and T. S. Wheeler .. .. III. 64
79. Studies in the chemistry of chalkones. By R. K. Kamat and T. S. Wheeler .. .. III. 64
80. Rottlerin. Part IV. By K. S. Narang and J. N. Ray .. III. 64
81. Acridine derivatives. Part II. By B. S. Duegan, K. S. Narang and J. N. Ray .. .. .. III. 64
82. Studies in coumarins. By D. R. Kulkarni, N. M. Shah and R. L. Alimchandani .. .. .. III. 64
83. Synthesis of coumarins from *o*-hydroxy-aryl alkyl ketones. By D. Chakravarti and N. Dutt .. .. III. 65
84. Synthetical experiments in the pyrone series: attempted oxidation of chromanones with selenium dioxide. By D. Chakravarti and J. Dutta .. .. .. III. 65
85. The influence of halogen atom on Kastanecki's reaction in the formation of α- and γ-pyrones. By D. Chakravarti and B. Majumdar .. .. III. 65
86. Synthesis of coumarino-coumarin, coumarino-chromone and chromono-chromone derivatives. By D. Chakravarti and N. Chakravarti .. .. .. III. 66
87. Studies in hydroxy and methoxy benzoic acids. By H. V. Dharwarkar and R. L. Alimchandani .. .. III. 66

PAGE

88. γ-substitution in the resorcinol nucleus. Part III. Synthesis of 2: 6-dihydroxy 3-ethyl benzaldehyde. By H. A. Shah and R. C. Shah .. .. .. III. 67
89. γ-substitution in the resorcinol nucleus. Part IV. By H. A. Shah and R. C. Shah .. .. .. III. 67
90. Studies on the substituted amides of cyanacetic acid. Part I. Velocity of saponification of the substituted amides of the cyanacetic acid of the type: $CN . CH_2CONHR$. By K. G. Naik, R. K. Trivedi and H. P. Parikh .. .. III. 67
91. Studies on the substituted amides of the cyanacetic acid. Part II. Preparation of the chloro derivatives of the substituted amides of cyanacetic acid. By K. G. Naik, R. K. Trivedi and H. P. Parikh .. .. III. 68
92. Studies on the substituted amides of cyanacetic acid. Part III. The velocity of the replacement of the chlorine atoms by hydrogen in the compounds of the type $CN–CCl_2–CONHR$. By K. G. Naik, R. K. Trivedi and H. P. Parikh .. .. III. 68
93. Benzylidene-coumaranones considered as chalkones. By T. B. Panse and T. S. Wheeler.. .. .. III. 68
94. Enolization of diaroylmethanes. By R. B. Shenoi and T. S. Wheeler .. .. III. 69
95. The stereochemistry of pinane and its derivatives. By K. Ganapathi .. .. III. 69
96. Configuration of the 2 : 3-dihydroxy-transdecalins. By K. Ganapathi .. .. III. 69
97. Cis-trans conversion of compounds occurring in essential oils by means of selenium dioxide. By B. Sanjiva Rao and (Miss) Mary Mathen .. .. .. III. 69
98. *C*-Benzoylation of β-aryl-glutaconic anhydride. By G. R. Gogte .. .. III. 69
99. *C*-Acetylation of β-aryl-glutaconic anhydrides: formation of $\alpha\gamma$-diaceto-β-aryl-glutaconic anhydrides. By G. R. Gogte .. .. III. 70
100. Isomerization of oleic acid by nickel catalyst. By V. T. Athavale and S. K. K. Jatkar .. .. .. III. 70
101. The constitution of oxycellulose and hydrocellulose. By S. R. Ramachandran and K. Venkataraman .. III. 70
102. On the constitution of tambulin. By P. K. Bose .. III. 71
103. The sulphonation of monoethylaniline. By I. S. Uppal and K. Venkataraman .. .. .. III. 71
104. Studies in the naphtol AS series. Part III. Synthetical experiments. I. By R. V. Bhat, R. B. Forster and K. Venkataraman .. .. .. III. 71
105. The reaction of some aromatic diamines with ethyl malonate. By T. N. Mehta and V. B. Thosar .. .. III. 72
106. Halogenation. Part XXIII. Halogenation of 2 : 6 dimethylnaphthalene. By P. S. Varma and S. Srinivasa Rao .. .. III. 73
107. Halogenation. Part XXIV. Halogenation of acenaphthene. By P. S. Varma and K. Subramanian .. III. 73

PAGE

108. Extension of the Nidhone process for the syntheses of 2-acyl-resorcins to 2-acyl-4-alkyl-resorcins. Part I. Synthesis of 2-acetyl-4-ethyl-resorcin. By S. D. Limaye III. 73

109. The alkyration of 2-methyl-, 3-methyl and 4-methyl-cyclohexylidene cyanoacetates. By R. D. Desai and G. S. Sahariya .. .. III. 74

110. On 2-phenyl-4-amino-quinoline derivatives. By U. P. Basu and P. Das Gupta .. .. .. III. 74

111. On the stability of oils. By U. P. Basu and A. Mazumder III. 74

112. Reactivity of aryl-*o*-alkoxystyryl ketone dibromides. By N. A. Bhagwat and T. S. Wheeler .. .. III. 75

113. Experiments on the synthesis of podophyllotoxin and podophyllin. By B. S. Duegan, K. S. Narang and J. N. Ray .. .. III. 75

114. Cane wax I. Non-saponifiable matter of the wax. By N. L. Vidyarthi and M. Narasinga Rao .. .. III. 75

115. Cane wax II. Composition and constitution of the fatty-acids of the wax. By N. L. Vidyarthi and M. Narasinga Rao .. .. III. 75

116. Bridging of succinosuccinic ester: on synthesis of compounds of tricyclene type. By P. C. Guha .. III. 76

117. Action of aliphatic diazo-compounds on cyclic conjugated double bonded systems. By P. C. Guha and G. D. Hazra .. .. III. 76

118. Synthetic textile auxiliaries. Part I. α-sulphonates of fatty acids and their substituted amides. By T. N. Mehta and D. M. Trivedi .. .. .. III. 76

119. Synthetic textile auxiliaries. Part II. α-pyridinium compounds of fatty acids and their substituted amides. By T. N. Mehta and D. M. Trivedi .. .. III. 77

120. Synthesis of lauralonic acid. By P. C. Guha and V. Rama Iyer .. .. III. 77

121. On synthesis of homocamphoronic and camphononic acids. By P. C. Guha and K. S. Subramanian .. .. III. 77

122. Synthetical experiments in the pinane group. Experiments towards the synthesis of pinonic acid. By P. C. Guha and P. L. Narasimha Rao .. .. III. 78

123. Synthetical experiments in the pinane group. The configuration of a-bromopinic acid and a-hydroxypinic acid. By P. C. Guha and P. L. Narasimha Rao .. III. 78

124. Synthesis of pyrene. By N. N. Chatterjee and G. N. Barpujari .. .. III. 79

125. Synthesis of β-isopropyl glutaconic acid. By S. K. Ranganatham .. .. III. 79

126. Synthesis of carane. By P. C. Guha and D. K. Sankaran .. III. 79

127. A new method of synthesis of umbellularic acid. By P. C. Guha and M. S. Muthanna .. .. .. III. 79

128. Attempts towards synthesis of thujadicarboxylic acid and thujaketonic acid. By P. C. Guha and M. S. Muthanna III. 80

129. Researches on total synthesis of thujone. By P. C. Guha and M. S. Muthanna .. .. .. III. 80

130. On synthesis of sabina ketone. By P. C. Guha and M. S. Muthanna .. .. III. 81

PAGE

131. Synthesis of bicycle-(2 : 2 : 2)-octane-(1 : 4)-dione. By P. C. Guha and C. Krishnamurthy .. .. III. 81
132. On the synthesis of 2 : 2 : 3-trimethyl-cyclohexan-4-one-1-carboxylic acid. By P. C. Guha and D. Das Gupta .. III. 82
133. Synthesis of methoxy and ethoxy phenarsazines. By P. S. Varma and K. S. Venkat Raman .. .. III. 82
134. Indigoid vat dyes of the isatin series. Part III. By S. K. Guha .. .. III. 83
135. Studies in indigoid dyes. Part IV. By S. K. Guha .. III. 83
136. Photosensitizing dyes. The influence of anions on the properties of dyes derived from α-picoline. By M. Q. Doja .. .. III. 83
137. Attempts to prepare azine and azonium dyes from isatin. By A. C. Sircar and A. K. Guha .. .. III. 83
138. Unsaturation in shellac. By H. K. Sen, M. Venugopalan and S. C. De .. .. III. 84
139. Wetting agents. Part IV. Further derivatives of arylamine sulphonic acids. By I. S. Uppal and K. Venkataraman .. .. III. 84
140. Composition of the fatty acids in the glycerides of *Garcinia Indica* (Kokum butter). By C. J. Dasa Rao and N. L. Vidyarthi .. .. III. 85
*141. The reactions of ketones with unsaturated hydrocarbons. By M. Omar Farooq .. .. .. III. 85

INDUSTRIAL CHEMISTRY.

142. Preparation and application of liquid gold. By Atma Ram, M. A. Saboor and Lal C. Verman .. .. III. 85
143. Setting properties of red lead paints. By N. Ghatak and Lal C. Verman .. .. III. 85
144. Studies on some characteristics of Indian coking coals. By R. K. Dutta Roy .. .. .. III. 86
145. Low temperature carbonization of Indian coals. By S. S. Ghosh, S. K. Roy and B. C. Roy .. .. III. 86
146. Studies into the suitability of some Northern India quartzites for the manufacture of silica bricks. By J. L. Sarin and K. K. Nijhawan .. .. III. 86
147. Characteristics of dry cells made from various Indian pyrolusite ores. By G. D. Joglekar, K. Subba Ramaiah, D. S. Naidu and Lal C. Verman .. .. III. 86
148. Examination and classification of siliceous and felsphathic materials of Indian origin for glass manufacture. By M. A. Saboor, S. V. Anantakrishnan and Lal C. Verman III. 87
149. Some problems in tinning of articles of complicated shapes and contours. By H. Trivedi and Lal C. Verman III. 87
150. Action of ammonia gas on lac. By A. K. Thakur .. III. 87
151. Manufacture of garnet lac from by-products of lac. By M. Rangaswami and H. K. Sen .. .. III. 88
152. Condensation of shellac and shellac acids with alcohols, aldehydes, acids and acid anhydrides. By M. Venugopalan and H. K. Sen .. .. .. III. 88
153. Manufacture of de-waxed lac. By M. Rangaswami and H. K. Sen .. .. III. 89

PAGE

154. Modifications of the soft resin from shellac. By M. Venugopalan and H. K. Sen .. .. .. III. 89
155. Modification of shellac with aniline and formaldehyde. By M. Venugopalan and H. K. Sen .. .. III. 89
156. Shellac moulding powders. By S. Ranganathan and H. K. Sen .. .. III. 90
157. Separation of lac into sclerolac and soft lac. By M. Sreenivasaya and A. Venkatasubban .. .. III. 90
158. Utilization of lac dust or molamma. By A. Venkatasubban and M. Sreenivasaya .. .. .. III. 90
159. Dielectric strength of lacs of known origin. By A. Venkatasubban, M. V. Kesava Rao and M. Sreenivasaya .. III. 90
160. The use of emulsified organic solvents in textile processing. By M. B. Desai and K. Venkataraman .. .. III. 90
161. The estimation of salicylanilide in textiles. By R. B. Forster, R. C. Gandhi and K. Venkataraman .. III. 91
162. Hydrogenation of oils by the continuous process. By R. V. Joglekar, V. T. Athavale and S. K. K. Jatkar .. III. 91
163. Cracking of vegetable oils. Part I. Groundnut oil. By N. M. Dalal and T. N. Mehta .. .. III. 92
164. Cracking of vegetable oils. Part II. Mowrah oil. By N. M. Dalal and T. N. Mehta .. .. .. III. 92
165. Utilization of Indian vegetable oils. Iodized oils. By S. Rangaswami .. .. III. 92
166. Utilization and properties of rice bran and oil derived from it. By Karimullah, N. Ghatak, J. S. Aggarwal and Lal C. Verman .. .. III. 92
167. Some Northern India essential oils. By J. L. Sarin and M. L. Beri .. .. III. 93
168. Physical and chemical properties of water cultrop starch. By J. L. Sarin and R. L. Saigal .. .. III. 93
169. Constituents of gram germ oil. By J. L. Sarin and S. L. Kapur .. .. III. 93
170. Catalytic polymerization of oils. By M. N. Goswami .. III. 93
171. Sulphocyanide value of oils. By M. Goswami and A. Choudhury .. .. III. 94
172. Preparation of a simple form of high vacuum grease. By A. Purushotham .. .. .. III. 94

BIOCHEMISTRY.

173. Nutrition studies in Bihar. Part II. Chemical composition of some of the local edibles. By K. Mitra .. III. 94
174. Cataphoretic velocity and surface condition of polymorphonuclear leucocytes from rabbits suspended in different media. By S. N. Mukherjee .. .. III. 94
175. Effect of addition of calcium on the biological value of the proteins of Indian diets. By V. Ranganathan and Y. V. S. Rau .. .. III. 95
176. Biological value of the proteins of a few typical Indian diet. By Y. V. S. Rau and V. Ranganathan .. III. 95
177. The availability of calcium and phosphorus in a few typical Indian diets. By V. Ranganathan .. III. 95

PAGE

178. Vitamin A and C changes in the mangoes during ripening. By G. B. Ramasarma and B. N. Banerjee .. .. III. 95
179. Pectic change and organic acids in fruits. Part I. By P. Neogi and K. L. Mandal .. .. .. III. 96
180. Sugar-acid-pectin relationship in the stabilization of fruit juices. By N. N. Chopra .. .. .. III. 96
181. Enzymes in snake venom. By B. N. Ghosh and D. K. Chowdhury .. .. III. 96
182. Intermediate compounds in the biological oxidation of ammonia by nitrifying organisms. By W. V. B. Sundara Rao, P. V. Krishnamurty and G. Gopalarao .. III. 96
183. The disintegration of tobacco mosaic virus preparations with sodium dodecyl sulphate. By M. Sreenivasaya and N. W. Pirie .. .. III. 97
184. Morphology and physiology of indigenous yeasts. By N. N. Chopra .. .. III. 97
185. Chemotherapy of bacterial infections. By K. Ganapathi III. 97
186. Oxidation-reduction potentials of *vibrio choleræ* and related organisms. By B. N. Mitra .. .. .. III. 97
187. Study of pectin content of bagasse. By K. G. Mathur .. III. 97

ANALYTICAL CHEMISTRY.

188. A rapid and simultaneous method of determining nitrogen and sulphur in coal. By K. L. Roy .. .. III. 98
189. A note on some modifications of Pregl's method for the micro-analytical determinations of carbon and hydrogen in the humid atmosphere of tropical summer. By M. C. Nath .. .. III. 98
190. A fine adjustment device for use with the micro-Dumas' apparatus. By S. Rangaswami .. .. III. 98
191. Micro-determination of the kinetics of tyrosine-tyrosinase action. By M. Sreenivasaya and K. Linderstrøm-Lang III. 98
192. Estimation of members of naphtol AS series. By T. N. Mehta and V. B. Thosar .. .. .. III. 99
193. A new method for estimating hydrogen by absorption in technical gas analysis. By H. N. Banerjea, L. A. Bhatt and R. B. Forster .. .. III. 99
194. Estimation of gold in cyanide solutions. By B. Shah and K. R. Krishnaswami .. .. .. III. 99
195. Estimation of calcium in different varieties of rice by two methods. By V. V. S. Murthy and Y. V. S. Rau .. III. 99
196. Elimination of titanium from a mixture of the oxides of titanium, niobium and tantalum. By S. Gopala Rao and K. R. Krishnaswami .. .. .. III. 100
197. Estimation of zinc in presence of copper, silver and mercury by means of quinaldinic acid. By P. R. Ray, N. K. Dutt and T. C. Sarkar .. .. .. III. 100

MISCELLANEOUS.

198. Dioxane as a cryoscopic solvent for shellac. By G. N. Bhattacharya and H. K. Sen .. .. .. III. 100

PAGE

199. New local anaesthetics. Part IV. By K. N. Gaind and J. N. Ray .. .. III. 101
200. A study of Kolhapur waters from different sources. By J. J. Airan and S. V. Shah .. .. .. III. 101

Section of Geology.

ECONOMIC GEOLOGY.

1. Sub-artesian effect at Yedrami, Andola Taluq of Gulberga District. By C. Mahadevan .. .. .. III. 103
2. Some Punjab clays. By J. L. Sarin and K. K. Nijhawan.. III. 103
3. Red ochre deposits in the Punjab. By J. L. Sarin and K. K. Nijhawan .. .. III. 103
4. Geology of the chromite deposit of Jojohatu, Singhbhum. By B. S. Bhadauria .. .. .. III. 104

MINEROLOGY AND PETROLOGY.

5. Miscibility amongst the various feldspar members as revealed by a study of the feldspars from the micapegmatites of Nellore. By N. Jayaraman .. . .. III. 104
6. Royite, a new mineral, from the Jharia coal-field. By N. L. Sharma .. .. III. 104
7. On fibrous quartz from the Bababudan Hills, Mysore State. By C. S. Pitchamuthu .. .. .. III. 104
8. Cordierites from Mysore. By M. R. Srinivasa Rao .. III. 105
9. On the petrology of the felsite of Galipuje, Mysore State. By C. S. Pitchamuthu .. .. .. III. 105
10. Study of Panjal Traps in the neighbourhood of Srinagar, Kashmir. By Raj Nath and P. N. Ganjoo .. III. 105
11. The occurrence of acid rocks in the Deccan Trap of the north of Salsette Island, Bombay. By A. S. Kalapesi and H. S. Dalal .. .. III. 105
12. On the origin of the charnockites. By N. Jayaraman .. III. 106
13. Some sedimentary structures in the Manglur Band of Dharwars. By C. Mahadevan .. .. III. 106
14. Tremolite marbles from Singareni, Warangal District (Hyderabad). By N. Jayaraman .. .. III. 107

STRATIGRAPHY AND PALÆONTOLOGY.

15. A few observations on the stratigraphical sequence of some of the Purana sedimentaries, North Krishna Basin, Nalgonda District, Hyderabad State. By S. K. Mukherjee and L. S. Krishnamurthy .. .. III. 107
16. The age of some metamorphosed sedimentary rocks in parts of Warangal District, Hyderabad State. By Syed Kazim and C. Mahadevan .. .. III. 108
17. Rhynchonellids from the Cretaceous Series of South India. By G. W. Chiplonkar .. .. .. III. 108
18. On some limestones from the cretaceous rocks near Pondicherry. By L. Rama Rao .. .. III. 108

Section of Geography and Geodesy.

PAGE

1. Markets of Calcutta. By A. K. Banerjee .. .. III. 109
2. Geography of Puri and adjoining areas, Orissa. By S. P. Chatterjee .. .. III. 109
3. Gneissic topography of Ranchi Plateau, Chota Nagpur. By S. P. Chatterjee .. .. .. III. 109
4. Geography of the town of Krishnagar, Bengal. By S. P. Chatterjee and B. M. Acharya .. .. III. 109
5. Naturvolkers of Chittagong Hill Tracts, Bengal. By D. C. Dasgupta .. .. III. 109
6. The growth of a modern city. By C. M. Ramachandra Chettiyar .. .. III. 110
7. Some dynamic problems of Indian Geography. By Arthur F. Geddes .. .. III. 110
8. Fisheries of Cochin. By A. Karunakara Menon .. III. 110
9. Utilization of lands seasonally water-logged. By A. Karunakara Menon .. .. .. III. 111
10. Recent irrigational changes and their effects in Grand Anicut Canal Region (Tanjore). By T. Krishnaswami.. III. 111
11. Sugarcane cultivation in India. By George Kuriyan .. III. 111
12. Potential spas of Sind. By Maneck B. Pithawalla .. III. 112
13. Problems of Greater Karachi—geographical solution through forming satellite towns in 12-mile circle. By Maneck B. Pithawalla .. .. III. 112
14. The source of the Brahmaputra. By Swami Pranavananda III. 112
15. The tanning industry in South India. By K. Ramamurthy III. 113
16. The cheyyar basin. By K. Sundaresan .. .. III. 113
17. The traditional limits and sub-divisions of the Tamil region. By B. M. Thirunaranan .. .. .. III. 113
18. The floods of 1937 in the Tamil Nad. By B. M. Thirunaranan and V. E. Naganatha Rao .. .. III. 113
19. Geography of the Casuarina plant. By T. P. Venkatachari .. .. III. 114
20. Geographical personality of Coorg. By K. S. Venkataraman .. .. III. 114

Section of Botany.

FUNGI.

1. Taxonomic studies in Indian smuts. By B. B. Mundkur .. III. 115
2. On the character of *Choanephora cucurbitarum* (B. and Rav.) Thaxter, causing a wet rot of chillies. By S. Sinha .. .. III. 115
3. A new species of *Bombardia* occurring on dry twigs of *Thunbergia grandiflora* Roxb. By G. S. Verma .. III. 115
4. An abnormal sterile form of *Polystictus sanguineus* Linn. By S. R. Bose .. .. III. 116
5. A wet rot of leaves of *Colocasia antiquorum* due to secondary infection by *Blakslea trispora* and *Choanephora cucurbitarum* (B. and Rav.) Thaxter. By S. Sinha .. III. 116
6. Investigation of orange rot in storage. By P. N. Ghatak.. III. 116

PAGE

7. Studies in the diseases of *Mangifera indica* Linn. III. On the 'die-back' disease of the mango tree. By S. N. Das Gupta and (Miss) A. T. Zachariah .. .. III. 117
8. Studies in the diseases of *Mangifera indica* Linn. II. Investigation into the pathological histology of the fruits affected with black-tip disease. By S. N. Das Gupta and S. Sinha .. .. III. 117
9. *Neotiella catharinœa* McLennan and Halsey on *Catharinœa mülleri*. By S. N. Das Gupta and T. S. Sadasivan .. III. 118
10. Effect of certain poisonous chemicals upon the spores of *Acrothecium lunatum* and *Caphalotheium roseum*. By G. S. Dhillon .. .. III. 118
11. *Acrothecium lunatum* on *Pennisetum typhoideum* ears. By G. S. Dhillon .. .. III. 118
12. A study of *Monascus* occurring in orange-squash. By G. S. Dhillon .. .. III. 118
13. Two species of *Spicaria* from interesting habitats. By G. S. Dhillon .. .. III. 118

BRYOPHYTA.

14. Studies in Indian hepaticæ. I. On two new species of *Leptocolea* S. from the Western-Himalayas. By S. K. Pande and R. N. Misra .. .. .. III. 119
15. Studies in Indian hepaticæ. II. On the epiphyllous liverworts of India. By R. N. Misra .. .. III. 119
16. Studies in Indian hepaticæ. III. On a new species of *Nowellia*; *N. indica* Pande et Srivastava, from the Western-Himalayas. By S. K. Pande and T. N. Srivastava .. .. III. 119

PTERIDOPHYTA.

17. Some observations on the Microsporocarps, Microsporangia and the male prothallium of Azolla pinnata, R.BR. By B. N. Mulay .. .. .. III. 119
18. Fertilization in *Azolla pinnata*, R.BR. By B. N. Mulay .. III. 120

ANGIOSPERMS. (i) MORPHOLOGY.

19. The development of the gametophytes in *Fumaria indica* pugsley. By (Miss) S. Rai .. .. .. III. 120
20. Studies in the order Parietales II. A contribution to the morphology of *Garcinia livingstonii* T. Anders. By V. Puri .. .. III. 120
21. Determination of sex in plantain flowers. By A. C. Joshi .. .. III. 120
22. Origin of the lateral styles. By A. C. Joshi .. .. III. 121
23. The origin of the angiosperms: A review of the present position. By A. C. Joshi .. .. .. III. 121
24. Origin of the seed habit. By A. C. Joshi .. .. III. 122
25. Embryo-sac and pollen development in *Iphigenia indica* (Liliaceæ). By A. C. Joshi .. .. .. III. 122
26. Some abnormal flowers of *Argemone mexicana* and their bearing on the morphology of the gynæceum of Papaveraceæ. By A. C. Joshi .. .. .. III. 122

PAGE
27. Morphology of *Tinospora cordifolia* Miers, with a discussion on the origin of the single integument, nature of synergidæ and relationships of the menispermaceæ. By A. C. Joshi .. .. III. 123
28. Relationships of the *Lythraceæ* and allied families. By A. C. Joshi .. .. III. 123
29. Morphological and cytological studies in Scrophulariaceæ. By V. K. Srinivasan .. .. .. III. 123
30. Development of the female gametophyte in *Capparis aphylla* Roth. By (Miss) S. Rai .. .. .. III. 123
31. Development of the female gametophyte in *Oligomeris glaucescens* Cambess. By P. C. Joshi .. .. III. 124
32. Observations on the pollination, and the phenomena connected with it in *Eugenia jambolana*. By N. K. Tiwary III. 124

ANGIOSPERMS. (ii) ANATOMY.

33. Formation of false growth rings in chirpine (*Pinus longifolia*, Roxb.) and its relation to growth factors. By K. Amad .. .. III. 124
34. Relation between cambial activity and foliar development in some forest trees. By K. Ahmad Chowdhury .. III. 125
35. Systematic anatomy of *Sesamum laciniatum* Klein. with special reference to its mucilage glands. By M. Sayeedud Din .. .. III. 125

PHYSIOLOGY AND ECOLOGY.

36. Phosphorus nutrition of wheat. By S. M. Sircar .. III. 125
37. A study on the rate of respiration in relation to nitrogen metabolism of potato tuber. By S. M. Sircar .. III. 125
38. March of transpiration of a leaf from the earliest stage to its fall. By P. Parija and B. Samantarai.. .. III. 126
39. Observations on the vegetation found round about Laki and Manga Pir—two hot springs in Sind. By B. N. Mulay and G. D. Bhavani .. .. .. III. 126
40. Some ecological observations on the life history of Azolla pinnata, R.BR. By B. N. Mulay .. .. III. 126
41. The flora of Mussoorie. By R. R. Stewart .. .. III. 126

PALÆOBOTANY.

42. On the anatomy of a fossil dicotyledonous wood from Nailalung, Assam. By K. Ahmad Chowdhury and S. Ghosh .. .. III. 127
43. The Pleistocene flora of Kashmir, Part (I). By G. S. Puri.. III. 127

TAXONOMY.

44. Euphorbiaceæ of the town of Dacca and its neighbourhood. By H. K. Dutta .. .. III. 128

GENERAL.

PAGE

45. The work of the Forest Research Institute, Dehra Dun. By R. Maclagan Gorrie .. .. .. III. 128

Section of Zoology.

1. On a new gregarine from the intestine of the Indian centipede—*Cormocephalus dentipes* Proc. By M. Chakravarty .. .. III. 129
2. The morphology and life-history of a Coccidian *Myriospora polydorae* n.sp., in the body-cavity of *Polydora ciliata.* By P. N. Ganapati .. .. .. III. 129
3. Studies on the flagellates (Mastigophora) found in the intestines of the common Indian snakes. By A. N. Mitra .. .. III. 129
4. On *Cœloplana* spp. discovered by Prof. Tattersall at Krusadai Island, Marine Biological Station, Gulf of Manaar. By D. W. Devanesan and S. Varadarajan .. III. 129
5. A brief survey of the development of the knowledge of Trematode fauna of India. By G. D. Bhalerao .. III. 130
6. Observations on the anatomy of *Acanthostoma burminis* (Bhalerao, 1928). By G. D. Bhalerao .. .. III. 130
7. Discussion on the validity of *Moniezia denticulata* (Rudolphi, 1810) (= *alba* Perroncito, 1879) Blanchard, 1891. By Mohammad Amin .. .. .. III. 130
8. On a new variety of *Avitellina sudanea* (Cestoda) with a note on the anomaly in its genitalia. By Mohammad Amin .. .. III. 131
9. On the nematode *Camallanus anabantis* Pearse. By G. K. Chakravarty .. .. III. 131
10. The recent placuna pearl fishery in Baroda and some notes and the window-pane system. By S. T. Moses .. III. 131
11. The development of *Temnopleurus toreumaticus* (Klein). By M. Anantaraman .. .. .. III. 131
12. Development of *Herdmania pallida.* By V. O. Sebastian.. III. 132
13. On the bionomics, structure and physiology of respiration in an air-breathing brackish water eel, *Pisoodonophis boro* (Ham. Buch.). By B. K. Das .. .. III. 133
14. On a collection of elasmobranch embryos obtained from the Madras coast. By R. Gopala Aiyar and (Miss) G. Mahadevan .. .. III. 134
15. On the food and the spawning season of *Sardinella brachysoma* (Bleek). By V. John .. .. .. III. 134
16. On the development of the vertebral column of *Lepidosteus osseus.* By H. K. Mookerjee and (Mrs.) S. Das .. III. 135
17. Fishes of Karachi. By Nazir Ahmad .. .. III. 135
18. On the so-called pyloric cæca in a marine fish, *Trichiurus savala,* Cuv. and Val. By M. Rahimullah.. .. III. 135
19. The food of the Mountain Barbel *Oreinus* McClelland and its probable bearing on the introduction of brown trout in Himalayan streams. By Ghulam Mustafa Malik .. III. 136
20. On the urino-genital and Müllerian ducts in the male of the common Indian toad *Bufo melanostictus.* By J. L. Bhaduri and A. K. Banerji .. .. .. III. 136

PAGE
21. Some aspects of the chondrocranium of the tadpoles of *Rana afghana* and *Megophrys*. By L. S. Ramaswami .. III. 136
22. The hyo-laryngeal apparatus of *Megophrys major* Blgr. By L. S. Ramaswami .. .. III. 137
23. The chromosomes of *Uraeotyphlus menoni* (Annandale). By B. R. Seshachar .. .. .. III. 137
24. On the occurrence and production of abnormal spermatozoa in the pigeon. By A. B. Misra and S. N. Mehrotra .. III. 137
25. Morphology of the ossicula auditus in the hedgehog (*Erinaceous collaris*) and the house-shrew (*Crocidura caerulea*). By K. L. Malhotra.. .. .. III. 137

ENTOMOLOGY.

26. Records of some insects from a hot spring in the Kulu Valley, Punjab. By H. S. Pruthi .. .. III. 138
27. Sex ratios of the desert locust, *Schistocerca gregaria* Forsk. in the solitary phase along the Baluchistan coast during the years 1932–1937. By M. L. Roonwal.. .. III. 138
28. Some notes on eyestripes in Acrididæ. By Y. Ramachandra Rao and R. L. Gupta .. .. .. III. 138
29. A neuro-muscular study of the mouth-parts of *Coccinella septempunctata* with a comparison of the mouth-parts in some Indian Coccinellids. By S. Pradhan.. .. III. 139
30. Glands in the head-capsule of Coccinellid beetles with a discussion on some aspects of gnathal glands. By S. Pradhan .. .. III. 139
31. Life-history of *Pterochlorus persicae* (peach-stem aphid). By A. S. Talwar .. .. III. 140
32. The life-history and morphology of *Euderus livida* (Ashmead) a larval parasite of the tur-pod fly, *Agromyza obtusa*. By Taskhir Ahmad .. .. .. III. 140
33. Some new parasitic Hymenoptera from India. By K. B. Lal .. .. III. 141
34. Growth and respiration in the galls of *Asphondylia riveae* Mani and *Odinadiplosis odinae* Mani (Itonididae: Diptera). By M. S. Mani .. .. III. 141
35. On a new Trombidiid larva parasitic on the house rat (*Rattus rattus* var.). By M. Abdussalam .. .. III. 141
36. Practicability of biological control in the lac industry. By P. M. Glover .. .. III. 142
37. The economic importance of *Microbracon greeni* Ash an ecto-parasite of *Eublemma amabilis,* the major predator of *Laccifer lacca,* lac. By S. N. Gupta and P. M. Glover .. .. III. 142
38. What is the correct taxonomic status of *Monophlebus quadricaudatus* Green. By S. Rammohan Rao .. III. 143
39. On the secretion of the ovisac by the female of *Drosichiella* (*Monophlebus*) *quadricaudatus* and its structure. By A. B. Misra .. .. III. 143
40. On the internal anatomy of the first stage larva of *Drosichiella* (*Monophlebus*) *quadricaudatus*. By S. Rammohan Rao III. 143
41. Damage to wheat, sugarcane, maize and fruit trees by termites in the Punjab. By M. S. Sarwar.. .. III. 144

PAGE

42. New species of termites recorded in the Punjab. By M. S. Sarwar .. .. III. 144
43. Taxonomic value of the structure of mandibles of workers in termites. By M. S. Sarwar.. .. .. III. 144
44. New sub-genus of the genus *Microtermes*. By M. S. Sarwar III. 144
45. New wood-destroying species of termites in the Punjab. By M. S. Sarwar .. .. III. 144
46. Effect of temperature and humidity on cocoon production of silk-worm, *Bombyx mori* L. By D. C. Sarcar .. III. 144
47. Effect of variable temperature and humidity upon different varieties of silk-worm. By D. P. Raichoudhury and S. B. Pal .. .. III. 145
48. On the mouth-parts of the silk-worm, *Bombyx mori* L. By D. P. Raichoudhury and H. L. Sarkar.. .. III. 145
49. On the reproductive system of the silk-worm, *Bombyx mori* L. By D. Mukerji and S. B. Pal .. .. III. 145
50. Experiments on the repeated pairings of *Bombyx mori* L. By D. P. Raichoudhury and S. P. Mookerjee .. III. 145
51. On the nervous system of silk-worm, *Bombyx mori* L. By S. B. Pal and H. L. Sarkar .. .. .. III. 145
52. On the differentiation of sex in the first stage larva of *Drosichiella* (Monophlebus) *quadricaudatus*. By S. Rammohan Rao .. .. III. 145
53. The life-history of the 'Stilt bug' *Metacanthus pulchellus* Dallas, with a note on the immature stages of Berytidæ (Neididæ)—Hemiptera—Heteroptera. By C. K. Samuel .. .. III. 146
54. Bionomics of two coccinellids *Adonia variegata* Goez. and *Brumus suturalis* F. predating on aphids. By A. P. Kapur .. .. III. 146

Section of Anthropology.

ETHNOLOGY.

1. Racial affinities of the Hindu population of Orissa. By A. K. Mitra and B. K. Chatterji .. .. III. 149
2. Substratum of Mediterranean element among the tribes of Sind and Baluchistan. By C. K. Roy .. .. III. 149
3. A plea for the reconsideration of the anatomical landmarks in craniometry. By R. N. Basu .. .. III. 149
4. Determination of the nasion in the living. By K. P. Chattopadhay .. .. III. 149
5. Studies on the hand-form of the Bengalis. By P. C. Biswas III. 149
6. The Pterion in Indian human crania. By R. N. Basu and M. N. Basu .. .. III. 150

ETHNOGRAPHY.

7. Indian Basketry—their texture and design. By B. S. Guha .. .. III. 150
8. The Vaghers of Okhamandal. By S. T. Moses.. .. III. 150
9. Some aspects of the material economy of Transgiri people. By Y. S. Parmar .. .. III. 150

PAGE
10. Marital life in the Transgiri tract. By Y. S. Parmar .. III. 151
11. Taboo and discipline of sex and family. By R. K. Mukerjee III. 151
12. The 'Shaman' personality: a psychological evaluation. By N. N. Sen Gupta .. .. .. III. 151
13. Mental diseases among the primitive people. By N. N. Sen Gupta .. .. III. 152
14. Totemism in Ancient India. By C. D. Chatterjee .. III. 152
15. The disposal of the dead among the primitive tribes of Travancore. By L. A. Krishna Iyer .. .. III. 152
16. The cultural national outlook. By S. C. Roy .. III. 153
17. Notes on the different types of apparatus used for smoking '*Pancharang*'. By B. K. Chaudhuri .. .. III. 153
18. The Sun as a folk God. By Nanimadhab Chaudhuri .. III. 153
19. Dynamics of caste. By R. N. Saksena .. .. III. 154
20. Prehistoric rock carvings. By D. Sen .. .. III. 154
21. A description of the Nicobarese rat-trap. By R. R. Mookerji .. .. III. 154
22. The Kabadi system in Bastar State. By T. C. R. Menon.. III. 154
23. Effect of culture-contact on the Garos of Assam. By J. K. Bose .. .. III. 155
24. Notes on a fish-gorge from Bengal. By T. C. Das .. III. 155
25. The Murias of Narayanpur, Bastar State. By Kr. Indrajit Singh and D. N. Majumdar .. .. .. III. 155
26. Caste and credit in rural society. By R. N. Saksena .. III. 155

Section of Medical and Veterinary Research.

A. MEDICAL RESEARCH.

MEDICINE AND PATHOLOGY.

1. A preliminary report on the possible etiological factor in the causation of infantile biliary cirrhosis being found in castor oil. By T. S. Tirumurti and K. Narayana Murthi .. .. III. 157
2. Infantile cirrhosis. (A case report.) By K. Narayana Murthi .. .. III. 157
3. Epidemiology of infantile cirrhosis. By K. Narayana Murthi .. .. III. 158
4. Endemic fluorosis in the Province of Madras. By T. N. S. Raghavachari and K. Venkataramanan .. .. III. 158
5. Chemotherapy and lymphogranuloma inguinale. By V. Govindan Nair and V. V. Chetty .. .. III. 158
6. Uleron in the treatment of gonorrhœa. By V. Govindan Nair and V. V. Chetty .. .. .. III. 159
7. Pellagra in Madras Presidency. Twenty-one cases of pellagra with treatment of five cases by nicotinic acid. By T. K. Raman .. .. III. 159
8. A study of the blood picture in septicæmic plague. By N. Seshadrinathan and D. R. Annamalai .. .. III. 160
9. The incidence of Filariasis in relation to malaria in Ceylon. By W. L. P. Dassanayake .. .. .. III. 160

PAGE
10. Studies in the pathology of hæmolymph organs in cholera. By H. N. Chatterjee .. .. .. III. 160
11. Studies in the pathology of the gastro-intestinal tract in cholera. By H. N. Chatterjee .. .. III. 161
12. Studies in the histo-pathology of the endocrine glands and the pathology of some other organs and tissues in cholera. By H. N. Chatterjee and J. K. Sarkar .. .. III. 161
13. Further studies in the biochemistry of anæmia of pregnancy. By H. N. Chatterjee and S. M. Ghosh .. .. III. 161
14. Further observations on 'coronary occlusion'. By J. N. Maitra .. .. III. 162

BACTERIOLOGY.

15. Longevity of coliform organisms in water stored under natural conditions. By T. N. S. Raghavachari and P. V. Seetharama Iyer .. .. .. III. 162
16. The technique of M.R. and V.P. tests used in bacteriological water analysis. By P. V. Seetharama Iyer and T. N. S. Raghavachari .. .. III. 162
17. The coli-aerogenes index of pollution used in water analysis. By T. N. S. Raghavachari and P. V. Seetharama Iyer .. III. 163
18. Staphylococcus aureus in vaccine lymph. By K. Padbhanabha Menon .. .. III. 163
19. Bacteriophage and candle filtration. By L. R. S. Deo .. III. 163

NUTRITION.

20. Insoluble ash of cereals and its effect on nutrition. By C. V. Sabnis and B. N. Banerjee .. .. III. 164
21. Calorie requirements of South Indian Children. By B. G. Krishnan .. .. III. 164
22. A survey of diet and nutrition in Najafgarh, Delhi Province. By K. L. Shourie .. .. III. 164
23. Serum phosphatase activity in rats fed with different diets. By K. V. Giri, K. L. Shourie and K. Rajagopal .. III. 165
24. The availability of cereal phosphorus and calcium for rats. By K. V. Giri .. .. III. 165
25. Interaction of Vitamin C and tissue phosphatases. By K. V. Giri .. .. III. 166
26. Diet in requirement of copper for infants. By U. P. Basu .. .. III. 166
*27. Studies on the availabilities of phosphorus and calcium in rice. By Y. V. S. Rau and V. V. S. Murthy .. III. 166

TOXICOLOGY.

28. Fatal poisoning by paranitraniline. By K. N. Bagchi, H. C. Chakravarti and H. D. Ganguli .. .. III. 166
29. Studies on toxicology of *Execaria agallocha* and difficulties in the way of medico-legal investigations. By K. N. Bagchi, H. D. Ganguli and P. N. Mukherjee .. III. 167

SURGERY.

PAGE

30. The treatment of dislocations of elbow and its complications with a simple technique for excision of elbow. By M. G. Kini .. .. III. 167
31. The use of tannic acid in burn. By C. A. Rothenheim and S. S. Cowalagi .. .. III. 168

GENERAL.

32. Medicine in India in the middle of 16th century. By D. V. S. Reddy .. .. III. 169

B. VETERINARY RESEARCH.

CLINICAL PATHOLOGY.

33. A clinical investigation into the etiology of rickets in pups of an indigenous Indian Breed. By P. C. Banerji and K. Raghavachari .. .. III. 170
34. Observations on malaria in buffaloes. By S. R. Hassan and M. R. Dhanda .. .. III. 170
35. Visceral gout of fowls in India. By S. Ganapathy Iyer .. III. 170
36. 'Deg Nala' disease of buffaloes—an account of the lesions and essential pathology. By J. F. Shirlaw .. III. 170

PROTOZOOLOGY.

37. Observations of *Babesia foliata*, n.sp. from a sheep. By H. N. Ray and K. Raghavachari .. .. III. 171

BACTERIOLOGY.

38. Biochemical classification of streptococci associated with strangles in India. By R. L. Kaura and S. Ganapathy Iyer .. .. III. 172
39. The value of synthetic media in the preparation of mallein. By R. L. Kaura .. .. III. 172
40. Detection of anthrax in food stuffs in an outbreak among mules. By V. R. Rajagopalan and V. R. Gopalakrishnan .. .. III. 172

ENTOMOLOGY.

41. Pasteurellosis in white mice. By V. R. Rajagopalan and V. R. Gopalakrishnan .. .. .. III. 173
42. Further observations on the bionomics of the ox warblefly (*Hypoderma lineatum*) in India. By B. N. Soni .. III. 173
43. On a new trombidiid larva parasitic on the house rat (*Rattus rattus* var.). By M. Abdussalam .. .. III. 173
44. A technique for cutting serial sections of chitinous objects. By S. N. Sapre .. .. III. 174
45. *Ornithodorus crossi*, Brumpt, 1921, as a valid species and not a synonym of *Ornithodorus papillipes*, Birula, 1895. By S. N. Sapre .. .. III. 174
46. The possibilities of cattle fly sprays in India. By S. K. Sen III. 174

HELMINTHOLOGY.

PAGE

47. A new unusual helminths of some domestic animals in India. By G. D. Bhalerao .. .. .. III. 175
48. A brief review of the species of schistosomes of the domesticated animals in India and their molluscan hosts. By M. Anant Narayan Rao .. .. .. III. 175
49. The importance and control of freshwater snails in veterinary research with special reference to work in Hyderabad State. By M. R. Mahajan .. .. .. III. 175
50. Studies upon the morphology of the larval forms of *Hypoderma crossii*. By B. N. Soni .. .. III. 176
51. A preliminary report on intestinal paramphistomiasis of sheep in Sind. By H. S. Bawa .. .. III. 176

BIOCHEMISTRY.

52. Normal clinical standards of equine blood. By N. D. Kehar and Mohan Singh .. .. .. III. 176
53. Daily variations in the serum protein fractions of buffaloes undergoing immunization by various methods against rinderpest and their relation to the potency of the serum. By R. L. Kaura .. .. III. 177

VITAMINOSIS.

54. Observations on avitaminosis-A in farm animals and how it is brought about. By N. D. Kehar .. .. III. 177
55. Deficiency diseases of animals in India. By K. C. Sen and N. K. Ayyar .. .. III. 177

VIRUS.

56. Infectivity of eggs in Doyle's (Ranikhet) disease. By R. L. Kaura .. .. III. 178
57. Rinderpest in sheep and goats. By H. S. Bawa .. III. 178
58. A successful method of vaccination against goat-pox. By R. L. Kaura and S. Ganapathy Iyer .. .. III. 178
59. Rinderpest in sheep in India. By R. L. Kaura .. III. 179
60. Some observations on the viability of Doyle's (Ranikhet) disease virus of fowls under different conditions. By S. Ganapathy Iyer .. .. III. 179
61. On the successful experimental transmission of variola in goats in a generalise form. By S. Ganapathy Iyer .. III. 179
62. Paralysis in a pigeon due to Doyle's (Ranikhet) disease. By S. Ganapathy Iyer .. .. .. III. 179
63. Blood chemistry of normal and hæmaturia animals. By N. D. Kehar .. .. III. 180
64. The association of aphosphoresis with contagious equine abortion. By N. D. Kehar .. .. .. III. 180

Section of Agriculture.

AGRONOMY.

1. Note on the tolerance of different types of cotton to alkaline soils in Sind. By B. B. Mulchandani .. .. III. 181

PAGE
2. Effect of soaking on germination of cotton seed. By B. B. Mulchandani .. .. .. III. 181
3. T.E.B. 1, an alkali-resistant strain of paddy for Nanjinad. By N. K. B. Kurupp .. .. .. III. 181
4. Varieties of mangoes cultivated in Travancore. By N. K. B. Kurupp .. .. III. 182
5. *Ipomœa hispida*, Roem and Sch., a useful fodder weed. By G. N. Rangaswami Ayyangar .. .. III. 182
6. Some observations on rice seed-testing. By H. K. Nandi and P. M. Ganguli .. .. III. 182
7. Studies on the metabolism and growth of Malta oranges. By J. C. Luthra and I. S. Chima .. .. III. 183
8. Variations in the concentration of juice in sugarcane. By P. V. Ramiah and T. Varahalu .. .. III. 183
9. Crop response to winter cultivation in Malwa. By G. C. Tambe and G. K. Sant .. .. .. III. 184

SOILS, FERTILIZERS AND MANURES.

10. Variations in the properties of hydrogen clays obtained from different clay subfractions of Indian soils. By R. P. Mitra and S. Chakravarty .. .. .. III. 184
11. On the nature of the red soils of Chota Nagpur Range and of Orissa. By S. P. Raychaudhuri .. .. III. 185
12. Studies on base-exchange reactions and lime-requirements of some Indian lateritic soils. By S. P. Raychaudhuri and A. B. Nandy Mazumdar .. .. .. III. 185
13. Influence of saturation with lime at pH 7·1 on some general physical properties of lateritic soils in relation to the Keen-Raczkowski box experiment. By S. P. Raychaudhuri and A. B. Nandy Mazumdar .. .. III. 185
14. On the ferrous iron content of Indian soils. By U. P. Basu and H. Goswami .. .. III. 186
15. Effects of alphos on sugarcane grown in an acid soil. By H. N. Pal .. .. III. 186
16. Studies in soil fertility. Part II. By A. L. Sundara Rao .. III. 187
17. Studies in soil fertility. Part III. By A. L. Sundara Rao III. 187

AGRICULTURAL BOTANY.

18. Certain suggested floral characters for distinguishing commercial sugarcane varieties. By N. L. Dutt .. III. 187
19. The behaviour and utility of three big bracts surrounding a flower. By V. N. Ranganatha Rao .. .. III. 188
20. Root studies of sugarcane in different types of soil under field conditions. By B. K. Dhar .. .. III. 188
21. The effect of environmental and genetical factors on fibre maturity of cotton. By A. N. Gulati and N. Ahmad .. III. 189
22. Some studies on the potentiality of imperfectly developed wheat grains. By J. C. Luthra and I. S. Chima .. III. 189
23. Shedding of buds, flowers and bolls of cotton in relation to environment and cultural factors. By Shamsher Singh and G. K. Sant .. .. III. 190

CROP PESTS AND DISEASES.

PAGE

24. Sugarcane borers and their control in the Mysore State. By T. V. Subramaniam .. .. .. III. 190
25. A new and simple contrivance for pohli (Carthamus Oxyacantha) eradication called 'Darshan Pohli Maru Datri'. By Darshan Singh and Nok Alam .. III. 191
26. The locust (*Schistocera*) with reference to Sind and Rajputana desert plants. By D. Bhatia .. .. III. 191
27. The rôle of food and its constituents on the productivity and longevity of the cotton stem weevil (*Pempheres affinis* FST.) of South India. By P. N. Krishna Ayyar and V. Margabandhu .. .. III. 192
28. Some non-insect pests and insectivorous animals of agricultural importance in S. India. By T. V. Ramakrishna Ayyar .. .. .. III. 192
29. Biological notes on insect pests of young graft mango plants in Cochin. By C. S. Venkitasubban and A. Neelakanta Iyer .. .. III. 193
30. Trials with the insectide from 'Derris elliptica' plant cultivated in Cochin. By C. S. Venkitasubban .. III. 193
31. The pea leaf miner, *Phytomyza atricornis* meig. in India. By Taskhir Ahmad and R. L. Gupta .. .. III. 193
32. Some Indian ants of economic importance and some methods of their control. By K. B. Lal.. .. .. III. 194
33. The *ak* grasshopper (*Poecilocerus pictus* F) as a pest of cultivated crops. By H. S. Pruthi and L. N. Nigam .. III. 194
34. A bethylid natural enemy of the sugarcane white moth borer. By M. C. Cherian and P. Israel .. .. III. 195
35. A caterpillar pest of grasses in S. India (*Cirphis albistigma*). By M. C. Cherian and K. P. Anantanarayanan .. III. 195
36. A new caterpillar pest of Moringa in S. India (*Noorda moringæ* T). By M. C. Cherian and Mohamed Basheer III. 195
37. The control of the rice grasshopper (*Hieroglyphus banian*, Fabr.) in South India. By Y. Ramachandra Rao and M. C. Cherian .. .. III. 196
38. Further studies on the cholam earhead bug (*Calocoris angustatus*) in S. India. By M. C. Cherian, M. S. Kylasam and P. S. Krishnamurthi .. .. .. III. 196
39. Some hairy caterpillar pests of S. India. By T. V. Ramakrishna Ayyar .. .. III. 196
40. Light reactions of *Trogoderma khapra* adults. By M. Afzal Husain and G. S. Sohi .. .. .. III. 196
41. Experiments on the summer control of plant mites. By A. N. Sapra .. .. III. 197

STATISTICAL METHODS.

42. Sampling in sugarcane experimental work. By M. Subbaiya III. 197
43. Variability of plant density and the estimation of yield of cotton by sampling. By R. J. Kalamkar and Dhannalal .. .. III. 198
44. An estimate of error from unreplicated experiments. By G. K. Sant .. .. III. 198

PAGE
45. A 10×10 quasi-factorial experiment at Chinsurah with 100 strains of rice. By K. R. Nair, S. C. Chakravarti and P. C. Mahalanobis .. .. .. III. 199
46. On a general method of constructing the appropriate compounds in terms of the twelve 3×3 Latin Squares for any of the eight components $N_1K_1P_1$, $N_1K_1P_2$, $N_1K_2P_1$, etc., of the second order interaction in a $3 \times 3 \times 3$ factorial arrangement. By K. Kishen .. .. III. 199
47. Split-plot technique in field experimentation. By K. Kishen .. .. III. 199
48. Some balanced confounded arrangements for the 5^n type of experiment. By K. R. Nair .. .. III. 200

AGRICULTURAL METEOROLOGY.

49. On radiation minimum temperatures. By L. A. Ramdas and K. M. Gadre .. .. III. 200
50. Dates of onset of the south-west monsoon on the west coast of India. By L. A. Ramdas, V. Satakopan and S. Gopal Rao .. .. III. 200
51. Studies on evaporation from the surfaces of soil layers resting on a water table. By L. A. Ramdas and A. K. Mallik .. .. III. 201
52. A study of transpiration in relation to meteorological factors. By A. K. Mallik .. .. .. III. 201
53. The invisible condensation of water vapour on the soil and on plant materials like stalk, leaves and grain. By A. K. Mallik .. .. III. 201
54. The use of the hot-wire anemometer in studies of microclimates. By P. K. Raman .. .. .. III. 201

MISCELLANEOUS.

55. Ancient farming lore with special reference to South India. By T. V. Rajagopalacharya .. .. .. III. 202
56. Darshan-Alam set of hoes and cultivators. By Darshan Singh and Nek Alam .. .. .. III. 202

Section of Physiology.

GENERAL PHYSIOLOGY.

1. Brain potential rhythm and levels of sleep. By B. K. Bagchi .. .. III. 203
2. Electrical stimulation of cerebral cortex followed by spreading and rhythmic grouping of brain potentials. By N. N. Das and N. N. De .. .. .. III. 203
3. Effects of (i) repetition of a single stimulus, applied directly or indirectly at an interval of 2 minutes, (ii) repetition of two successive stimuli under nearly the same conditions, and (iii) rapidly successive stimuli to frog's nerve-muscle preparation immersed in a solution of adrenalin or acetyl-choline in (*a*) Ca-free Ringer, or (*b*) K-free Ringer, or (*c*) Ringer, or (*d*) modified Ringer with varying concentrations of Ca or K. By G. C. Mukherjee III. 204

PAGE
4. Range of systolic blood pressure in healthy young students. By S. N. Mathur .. .. III. 205
5. Comfort in our trains. (Kata thermometer readings between Madras and Waltair). By D. V. S. Reddy.. III. 205
6. A method for recording the rate and depth of respiration in rabbits. (Demonstration.) By S. A. Rahman .. III. 206

BIOCHEMISTRY.

7. The active group of papain. By C. V. Ganapathy and B. N. Sastri .. .. III. 206
8. Natural activator of papainases. By C. V. Ganapathy and B. N. Sastri .. .. III. 206
9. The influence of ascorbic acid on the oxidases acting on adrenalin. By N. K. Iyengar and B. Mukerji .. III. 207
10. A preliminary note on the relationship between the copper content and the ascorbic-acid-oxidase activity of the different protein fractions separated from the drumstick juice. By N. M. Basu and G. K. Ray .. .. III. 207
11. Note on the duration of the activity of salivary enzymes on cloth. By S. N. Mathur .. .. .. III. 208
12. Estimation of conjugated glucuronic acid as a test for liver function. By B. Mukerji and R. Ghosh .. .. III. 208
13. Nonprotein nitrogenous constituents of blood. By S. K. Gokhale .. .. III. 208
14. Lead in human hair. By K. N. Bagchi, H. D. Ganguly and J. N. Sirdar .. .. III. 209
15. Estimation of inorganic phosphorous by absolute colorimetry. By D. N. Mullick .. .. .. III. 209
16. Histological chemistry of voluntary muscle. By A. Ghaffar III. 210
17. Nutrition studies in Bihar. I. (Dietary habits of the college students at Patna.) By K. Mitra .. .. III. 210
18. Endogenous protein metabolism of man and the distribution of sulphur in human urine on non-protein diet and on diets containing different amount of proteins of rice and whole wheat (Atta). By K. P. Basu, M. N. Basak and M. K. Haldar .. .. III. 210
19. Metabolism of calcium and phosphorus in human beings. By K. P. Basu, M. N. Basak and B. Raychowdhury .. III. 211
20. Sub-clinical Vitamin A deficiency studied by a photometer. By M. Narasimharao and G. Sankaran .. .. III. 211
21. The Vitamin B-complex in toxic conditions. By A. Mukherji .. .. III. 212
22. Observations on the state of saturation of Bengalee boys with regard to Vitamin C. By N. M. Basu and G. K. Ray .. .. III. 212
23. Observations on the minimum requirements of Vitamin C of Bengalee boys. By N. M. Basu and G. K. Ray .. III. 213
24. Free and total ascorbic acid content of some common Bengali foods before and after cooking. By R. Neogy III. 213
25. Applicability of Rotter's test in field investigations in the determination of Vitamin C deficiency. By D. D. Mitra and G. Sankaran .. .. III. 214
26. On the activity of liver concentrate. By U. P. Basu .. III. 214

PHARMACOLOGY.

PAGE

27. Studies on some dextro-rotatory hydrocupreidine derivatives. Part III. Action on *Paramoecium caudatum*. By B. Mukerji and R. N. Chopra .. .. .. III. 214
28. Action of drugs on the coronary flow. By B. Narayana .. III. 215
29. Correlation between chemical constitution, pharmacological action and enzymatic breakdown of certain adrenalin-like amines. By B. Mukerji and N. K. Iyengar .. III. 215
30. Some observations on the action of coramine as an analeptic. By B. N. Ghosh and P. C. Adhya .. .. III. 216
31. The effects of some ions on the action of Urea-stibamine on frog's heart. By P. Biswas .. .. .. III. 216

ANATOMY.

32. The lumbo-sacral plexus and the innervation of muscles in primitive mammals. By Brij Mohan Lal .. III. 216

Section of Psychology.

SENSATION, PERCEPTION AND MEMORY.

1. Visual perception of geometrical figure in indirect vision. By M. Ganguli .. .. III. 219
2. Towards a dynamic theory of space-perception. By N. N. Sen Gupta .. .. III. 219
3. The importance of visual image in tactual localization. By K. C. Mukherji .. .. .. III. 219
4. D.L. for lifted weights by the method of continuous increase of the standard. By Gopeswar Pal .. .. III. 219
5. An experimental study of the difference between lines visually apprehended and lines drawn. By N. N. Sen Gupta .. .. III. 220
6. The influence of colour on the estimation of area. By S. C. Mitra and A. Datta .. .. .. III. 220
7. Colour memory—an experimental study. By P. Razdon.. III. 220
8. An experiment on æsthetic value. By N. S. N. Sastry .. III. 221

GENERAL PROBLEMS.

9. Psychological study of language. By G. Bose and D. Ganguly .. .. III. 221
10. Fear and anger responses of adults. By Parsram .. III. 221
11. Psycho-analytical theory of meaning. Part I. By Kali Prasad .. .. III. 221
12. Psycho-ethics: ancient and modern. By B. C. Ghosh .. III. 222
13. A reconstruction of the Hormic theory of sentiments. By P. S. Naidu .. .. III. 222
14. On the questionaire method in psychology. By Parsram .. III. 222
15. The 'Social-Affective' Concept of Meaning. By S. K. Bose III. 223
16. This 'Factory' of Factorial School. By N. Mukherjee .. III. 223
17. Categories and concepts in Psychology. By Majid Zakaria III. 223
18. Contributions of Abnormal to Normal Psychology. By Indra Sen .. .. III. 223

EDUCATION AND TESTS.

PAGE
19. The psychological basis of creative work in school. By W. M. Ryburn .. .. III. 224
20. Psychology of the New Education Movement. By J. M. Sen .. .. III. 224
21. Measurement of mental qualities. By Emil W. Menzel .. III. 225
22. Group Tests of intelligence for Bengali scholars (class V–class X). By H. C. Banerjee, D. N. Roy and T. P. Bhowmik .. .. III. 225
23. Problems and difficulties of vocational guidance. By M. N. Banerji .. .. III. 225
24. The medium of examination and instruction. By S. S. Jalota .. .. III. 225
25. Matching method in the study of personality. By S. K. Bose .. .. III. 226
26. Reliability of repeated grading of English essays. By H. C. Banerjee .. .. III. 226
27. Pupils' preference for school subjects. By S. P. Chatterjee III. 226
28. Some aspects of measurement of Intelligence. By N. Mukherjee .. .. III. 226
29. Application of Dearborn Formboard tests. By D. Agarwalla and M. Samanta .. .. III. 226

PSYCHO-ANALYSIS AND PSYCHIATRY.

30. A psycho-analytical study on marriage. By W. A. Hobson III. 227
31. Modern treatment of Schizophrenia. By H. M. Selzer .. III. 227
32. Psychological investigation of insane murders. By R. S. M. Sarma .. .. III. 227
33. Kretschmer's theory and Behaviourism. By R. M. Loomba III. 227
34. Chemiotherapy of Schizophrenia. By D. Satyanand .. III. 228
35. A case of temporary loss of memory. By K. P. Chattopadhay .. .. III. 228
36. Therapeutical indications of frigidity in women. By H. M. Selzer .. .. III. 228
37. Attempt at interpretation of a Garo dream. By T. C. Sinha .. .. III. 228
38. The way to sublimation. By M. Samanta .. .. III. 229
39. Instincts in psycho-analysis. By N. K. Majumdar .. III. 229
40. A contribution to the study of conversion hysteria. By I. Latif .. .. III. 229

SOCIAL PSYCHOLOGY.

41. Religious experiences of Muhammad. By M. Aslam .. III. 229
42. Sensory aids in mystic life. By Raj Narain .. .. III. 229
43. Social psychology and rural reconstruction. By J. C. Heinrich .. .. III. 230
44. The culture of emotions in mystic life. By Raj Narain .. III. 230
45. The utility of psycho-analysis in social anthropology. By H.R.H. Prince Peter of Greece .. .. III. 230
46. The psychology of the beggars. By A. C. Bhatia .. III. 231

PAGE

47. Psychological aspects of some customs of the Sansi tribe. By A. H. Jameel Alawi .. .. .. III. 231
48. A psychological interpretation of the primitive pubescent ceremonies. By Jagdish Singh .. .. III. 232

CHILD PSYCHOLOGY.

49. A study of the free drawings of an eight year old child. By K. L. Shrimali .. .. III. 232
50. A psycho-analytical theory of play. By S. M. Mohsin .. III. 232
51. A study of anger in children. By Srimati B. Nagaratna .. III. 232
52. Behaviouristic peculiarity of feeble-minded children. By N. C. Bagchi .. .. III. 233

PHYSIOLOGICAL PSYCHOLOGY.

53. Electrical rhythm from the intact human brain. By B. K. Bagchi .. .. III. 233
54. Psychology of cardiac pain, its relation to sudden death and its anatomical basis. By J. N. Maitra .. .. III. 233
55. Human temperaments. By W. Burridge .. .. III. 233

PART IV—LATE ABSTRACTS, ERRATA AND ADDENDA, DISCUSSIONS, LIST OF MEMBERS AND INDEX

1. Late Abstracts :

Section I, Mathematics and Physics.

32(*a*). The absorption spectra of single crystals of Rare Earth Salts under polarised light. By D. C. Chakravarti.. IV. 1
32(*b*). Absorbability of scattered X-rays. By H. K. Pal .. IV. 1
32(*c*). A study of the energy distribution of scattered X-radiation. By H. K. Pal .. .. .. IV. 2
32(*d*). A study on the polarisation of X-rays. By H. K. Pal .. IV. 2
95. Paramagnetic studies on single crystals. By K. S. Krishnan, A. Mookherji and A. Bose .. .. .. IV. 3
96. Temperature variation of the magnetic anisotropy of $CuSO_4 \cdot 5H_2O$. By K. S. Krishnan and A. Mookherji .. IV. 3
97. The structure-sensitiveness and the Temperature-dependence of the abnormal unidirectional diamagnetism of graphite crystal. By K. S. Krishnan and N. Ganguli .. IV. 3
98. The figuring of a 24″ reflector made in India. By H. Parameswaran and S. Hariharan .. .. IV. 3
99. The making of a 6″ long focus (15′) achromatic objective. By H. Parameswaran and A. V. V. Krishna Rao .. IV. 4
100. A note on the method of parallax and the resolving power of the eye. By S. B. Mathur .. .. .. IV. 4

Section II, Chemistry.

PAGE

141(*a*). Hydrolysis of esters in heterogeneous systems. By D. D. Karve and V. L. Mehendale.. .. .. IV. 4

141(*b*). Hydrolysis of some aromatic and aliphatic nitrites by sulphuric acid. By D. D. Karve and D. V. Gharpure IV. 5

Section III, Geology.

6(*a*). Experiments on blending and swelling properties of some Jharia coals. By N. N. Chatterjee and B. C. Chakravarty.. .. .. IV. 5

Section V, Botany.

13(*a*) Leaf spots of *Agave americana* Linn. Caused by *Diplodia agaves*. By N. S. Madan .. .. .. IV. 5

13(*b*). *Pestalozzia phoenicis* on *Phoenix dactylifera*. By N. S. Madan .. .. IV. 6

Section VI, Zoology.

55. Breeding habits of *Anopheles sundaiens Rodenov*. By P. Sen IV. 6

56. An Arhynchobdellid leech, *Hœmopis sp.* from Kashmir (India). By M. L. Bhatia .. .. .. IV. 6

57. *Glossiphonia reticulata,* from the mantle of *Lamellidens,* the common freshwater mussel of Lucknow. By M. L. Bhatia .. .. IV. 7

Section VII, Anthropology.

27. Bengal coiled baskets. By K. P. Chattopadhyay .. IV. 7

Section VIII, Medical and Veterinary Research.

32(*a*). Serology in Radiation Therapy. By M. J. S. Pillai .. IV. 7

43(*a*). On a new feather mite paraphagistic on the Indian domestic fowl (*Gallus bankiva murghi*). By M. Abdussalam .. .. IV. 8

43(*b*). The occurrence of equine nasal bot, *Rhinœstrus purpureus* (Brauer, 1858) in India. By M. Abdussalam .. IV. 8

58(*a*). Rinderpest in sheep and goats in the Province of Bombay. By R. N. Naik .. .. IV. 8

Section IX, Agriculture.

17(*a*). A note on the relative efficiency of water requirements in relation to manurial treatments. By K. L. Khanna and P. C. Raheja .. .. .. IV. 8

23(*a*). Seasonal shoots in sugarcane. By K. L. Khanna and R. R. Panje .. .. IV. 9

Section X, Physiology.

PAGE

6(*a*). Tissue culture—its application in medical and biological researches. By N. N. Das .. .. .. IV. 9

31(*a*). Quality of cod liver oil in the Indian market. By N. K. Iyengar and B. Mukerji .. .. .. IV. 10

Section XI, Psychology.

56. New Psychology and its effect on creative literature. By A. Chakravarty .. .. IV. 10

57. Rhythm in modern Bengali. By Amalesh C. Sen and A. C. Sen .. .. IV. 10

58. Relation of thought and language. By D. L. Sharma .. IV. 11

59. Emotional growth in the education of a child. By U. S. Gheba .. .. IV. 11

60. Teacher and his make-up. By P. C. Lal .. .. IV. 11

2. Errata and Addenda, Part III—Abstracts, 26th I.S.C., Lahore .. .. IV. 12

3. Discussions :

I. The structure of Liquids .. .. .. IV. 13

Section of Mathematics and Physics.

II. Theoretical Statistics .. .. .. IV. 14

Section of Mathematics and Physics, in co-operation with the Statistical Conference.

III. Rôle of the modern geographer in India .. .. IV. 16

Section of Geography and Geodesy.

IV. A need for uniformity in the Physiographic Divisions of India .. .. IV. 18

Sections of Geography and Geodesy, Geology, Mathematics and Physics (for Meteorologists), Botany and Zoology.

V. The Agricultural Cycle .. .. .. IV. 19

Sections of Geography and Geodesy, Agriculture, Botany, Mathematics and Physics (for Meteorologists) and Zoology (for Entomologists).

VI. Zoogeography of India .. .. .. IV. 20

Section of Zoology.

VII. Scope of private enterprise in Archæological and Anthropological Research in India .. .. .. IV. 21

Section of Anthropology.

VIII. Application of statistical methods in Anthropological Research .. .. IV. 23

Section of Anthropology, in co-operation with the Statistical Conference.

PAGE

IX. Social disorganization .. .. .. IV. 24
Sections of Anthropology and Psychology.

X. Disease and pest resistance in crops .. .. IV. 27
Sections of Agriculture, Botany, Zoology, in co-operation with the Society of Biological Chemists, India.

XI. Erosion and drainage problems in India .. .. IV. 36
Sections of Agriculture, Physics, Veterinary Research, Geography and Geodesy, in co-operation with the Indian Society of Soil Science and National Institute of Sciences of India.

XII. Composts .. .. IV. 41
Sections of Agriculture, Medical and Veterinary Research, in co-operation with the Society of Biological Chemists, India.

XIII. Experimental Field trials. .. .. .. IV. 45
Section of Agriculture, in co-operation with the Statistical Conference.

XIV. The Place of Physiology in General Education .. IV. 46
Section of Physiology.

XV. Psychology in service of Education in India .. IV. 52
Section of Psychology.

XVI. Factors determining changes in Religious Phenomena .. IV. 55
Sections of Psychology and Anthropology.

4. List of Members, 26th I.S.C. .. .. .. IV. 58

5. Index .. .. IV. 95

Proceedings of the Twenty-sixth Indian Science Congress

PART I

CONTENTS

PAGE

1. **Officers of the Twenty-sixth Congress** 3
2. **Officers of the Indian Science Congress Association for 1938-39** 6
3. **Local Reception Committee** 12
4. **General** 15
5. **Opening Proceedings** 21
6. **Official** 25
    - (A) Delegates from the British Association for the Advancement of Science 25
    - (B) Delegates from Universities, Learned Societies, Colleges, States and Government Departments in India .. 25
    - (C) Financial Arrangements for the Twenty-sixth Session .. 27
    - (D) Meetings of the General Committee, the Council and the Executive Committee of the Indian Science Congress Association.. 28
    - (E) Resolutions adopted by Sections 39
    - (F) Rules and Regulations 40
    - (G) Statement of Accounts 49

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Chemistry.—Prof. S. S. Joshi, D.Sc., University Professor of Chemistry and Head of the Chemistry Department, Hindu University, Benares.

Geology.—Dr. C. Mahadevan, M.A., D.Sc., Assistant Superintendent, Geological Survey Department, Hyderabad, Deccan.

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Zoology.—Prof. S. G. Manavala Ramanujam, M.A., Ph.D., D.I.C., F.Z.S., F.R.M.S., Professor of Zoology, Presidency College, Madras, (up to Dec., 1938).

G. K. Chakravarty, Esq., Assistant Lecturer in Zoology, University of Calcutta; 32, Serpentine Lane, Calcutta, (from 1st Jan. to 31st Jan., 1939).

Anthropology.—Capt. R. N. Basu, M.Sc., M.B., Department of Anthropology, Calcutta University, 29, Townshend Road, Calcutta.

Medical and Veterinary Research.—Dr. Phanindranath Brahmachari, M.Sc., M.B., 19, Loudon Street, Calcutta.

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Chemistry.—S. N. Mukherjee, Esq., M.Sc., Assistant Lecturer in Chemistry, University College of Science, 92, Upper Circular Road, Calcutta.

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Anthropology.—S. S. Sarkar, Esq., M.Sc., P. 30, R. K. Chatterji Road, P.O. Dhakuria, Kasba, 24-Parganas, (up to September).

Dr. P. C. Biswas, M.Sc., Ph.D., c/o Dr. K. P. Biswas, Royal Botanic Garden, Sibpur, (from December, 1938 to January 31st, 1939).

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Agriculture.—Dr. Ramaprasad Mitra, D.Sc., University College of Science, 92, Upper Circular Road, Calcutta.

Physiology.—Dr. B. Mukerji, M.D., D.Sc., Pharmacologist, Biochemical Standardization Laboratory, All-India Institute of Hygiene and Public Health, Chittaranjan Avenue, Calcutta.

Psychology.—S. K. Bose, Esq., M.A., M.Sc., 5, Preonath Banerji Street, Calcutta.

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Geology.—Dr. N. K. Bose, Director, Irrigation Research Institute, Lahore.

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Psychology.—Prof. S. S. Jalota, M.A., Professor of Philosophy, Mahila Mahavidyalaya, 13, Multan Road, Lahore.

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HONORARY MANAGING SECRETARY:

Johan van Manen, Esq., C.I.E., F.R.A.S.B., 1, Park Street, Calcutta.

HONORARY TREASURER:

Percy Brown, Esq., A.R.C.A., F.R.A.S.B., Secretary and Curator, Victoria Memorial Hall, Calcutta.

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	Prof. P. Parija, M.A., F.N.I., I.E.S., (from October 19th).	
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11.	Rao Bahadur T. S. Venkatraman, C.I.E., B.A., I.A.S., F.N.I.	
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* Mr. W. D. West resigned the office of the General Secretary as he left India on a long leave and Prof. P. Parija was appointed the General Secretary from October 19th, 1938, for a period till the 31st January, 1939.

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Dr. A. M. Heron	*Past President who is an Ordinary Member.*
Mr. N. Subrahmanyam	*Past Recorder who is an Ordinary Member.*

This section was made a permanent one after the election of members to the various Sectional Committees.

5. Botany—

Dr. K. D. Bagchee	*Convener.*
Prof. Y. Bharadwaja	*Recorder.*
Prof. J. C. Sen-Gupta	*Sectional Correspondent.*
Prof. P. L. Anand	*Local Sectional Secretary.*
Dr. S. N. Das-Gupta	*Elected Members.*
Mr. A. C. Joshi	
Prof. B. Sahni	*Past Presidents who are Ordinary Members.*
Prof. S. P. Agharkar	
Prof. M. O. P. Iyengar	
Prof. K. C. Mehta	

Prof. P. Parija	*Past Presidents who are Ordinary Members.*
Dr. T. Ekambaram	
Dr. H. P. Chaudhuri	
Dr. S. L. Ghose	
Prof. R. H. Dastur	
Prof. J. H. Mitter	
Prof. S. R. Bose	
Mr. H. G. Champion	
Prof. S. L. Ajrekar	*Past Recorders who are Ordinary Members.*
Prof. J. H. Mitter	
Prof. S. R. Bose	
Dr. K. D. Bagchee	
Prof. G. P. Majumdar	
Prof. M. Sayeed-ud-Din	

6. **Zoology—**

Prof. C. R. Narayan Rao	*Convener.*
Prof. S. G. M. Ramanujam	*Recorders.*
Mr. G. K. Chakravarty	
Mr. J. L. Bhaduri	*Sectional Correspondent.*
Dr. Vishwa Nath	*Local Sectional Secretary.*
Prof. B. K. Das	*Elected Members.*
Mr. G. K. Chakravarti	
Dr. F. H. Gravely	*Past Presidents who are Ordinary Members.*
Prof. G. Matthai	
Prof. K. N. Bahl	
Dr. B. Prashad	
Dr. B. Sundara Raj	
Dr. S. L. Hora	
Dr. B. L. Bhatia	
Prof. D. R. Bhattacharyya	
Prof. R. Gopala Aiyar	
Prof. P. R. Awati	
Prof. H. K. Mookerjee	
Dr. G. S. Thapar	
Dr. M. A. Husain	
Dr. H. S. Rao	*Past Recorders who are Ordinary Members.*
Prof. H. K. Mookerjee	
Dr. H. N. Ray	
Dr. G. S. Thapar	
Mr. D. D. Mukerji	
Dr. H. S. Pruthi	

7. **Anthropology—**

Dr. D. N. Majumdar	*Convener.*
Capt. R. N. Basu	*Recorder.*
Mr. S. S. Sarkar	*Sectional Correspondents.*
Dr. P. C. Biswas	
Mr. C. R. Roy	*Local Sectional Secretary.*
Dr. P. C. Biswas	*Elected Members.*
Prof. M. H. Krishna	
Rai Bahadur S. C. Roy	*Past Presidents who are Ordinary Members.*
Prof. P. C. Mahalanobis	
Dr. J. H. Hutton	
Dr. B. S. Guha	
Prof. K. P. Chattopadhyay	
Dr. G. S. Ghurye	
Mr. H. C. Chakladar	

Mr. T. C. Das	*Past Recorders who are Ordinary Members.*
Mr. H. C. Chakladar	
Dr. G. M. Kurulkar	
Dr. D. N. Majumdar	
Mr. T. C. Roychoudhuri	

8. Medical and Veterinary Research—

Dr. T. S. Tirumurti	*Convener.*
Dr. P. Brahmachari	*Recorder.*
Rai Bahadur K. N. Bagchi	*Sectional Correspondent.*
Dr. Vishwa Nath	*Local Sectional Secretary.*
Capt. S. C. A. Datta	*Elected Members.*
Rai Bahadur K. N. Bagchi	
Brev.-Col. R. N. Chopra	*Past Presidents who are Ordinary Members.*
Sir U. N. Brahmachari	
Lt.-Col. S. S. Sokhey	
Lt.-Col. K. R. K. Iyengar	
Dr. M. B. Soparkar	*Past Recorders who are Ordinary Members.*
Dr. A. C. Ukil	
Rao Bahadur T. S. Tirumurti	
Prof. S. W. Hardikar	
Capt. S. C. A. Datta	

9. Agriculture—

Rao Sahib T. V. R. Ayyar	*Convener.*
Dr. C. N. Acharya	*Recorder.*
Dr. R. P. Mitra	*Sectional Correspondent.*
Dr. A. N. Puri	*Local Sectional Secretary.*
Prof. J. C. Luthra	*Elected Members.*
Mr. N. L. Dutt	
Rao Bahadur M. R. Ramaswami Sivan	*Past Presidents who are Ordinary Members.*
Sir B. C. Burt	
Rao Bahadur T. S. Venkatraman	
Sir T. Vijayaraghavacharya	
Rao Bahadur G. N. Rangaswami Ayyangar	
Mr. M. Afzal Husain	
Mr. A. K. Y. Narayan Aiyer	
Rao Bahadur B. Viswanath	
Mr. N. V. Joshi	*Past Recorders who are Ordinary Members.*
Rao Bahadur B. Viswanath	
Dr. S. V. Desai	
Mr. Y. D. Wad	
Dr. A. N. Puri	

10. Physiology—

Prof. N. M. Basu	*Convener.*
Prof. B. Narayana	*Recorder.*
Dr. B. Mukherji	*Sectional Correspondent.*
Dr. K. S. Grewal	*Local Sectional Secretary.*
Dr. B. B. Sarkar	*Elected Members.*
Dr. S. N. Ray	
Prof. W. Burridge	*Past Presidents who are Ordinary Members.*
Lt.-Col. S. L. Bhatia	
Bt.-Col. R. N. Chopra	
Prof. N. M. Basu	*Past Recorders who are Ordinary Members.*
Dr. S. N. Mathur	

11. Psychology—

Mr. H. P. Maiti	*Convener.*
Dr. D. D. Shendarkar	*Recorder.*
Mr. S. K. Bose	*Sectional Correspondent.*
Prof. S. S. Jalota	*Local Sectional Secretary.*
Principal H. Hyder Ali Khan	*Elected Members.*
Mr. G. Pal	
Dr. N. N. Sen Gupta	*Past Presidents who are Ordinary Members.*
Lt.-Col. O. A. R. Berkeley-Hill	
Prof. N. S. N. Sastry	
Dr. G. Bose	
Mr. M. N. Banerjee	
Dr. S. C. Mitra	
Principal J. M. Sen	
Mr. K. C. Mukherji	
Prof. N. S. N. Sastry	*Past Recorders who are Ordinary Members.*
Mr. M. N. Banerjee	
Mr. D. Ganguly	
Dr. D. D. Shendarkar	

3. LOCAL RECEPTION COMMITTEE.

PATRONS:

1. H.H. The Maharaja of Jammu and Kashmir.
2. H.H. The Maharaja of Patiala.
3. H.H. The Maharaja of Jind.
4. H.H. The Raja of Mandi.
5. H.H. The Raja of Faridkot.

CHAIRMAN:

Khan Bahadur Mian M. Afzal Husain, M.A., M.Sc., F.N.I., Vice-Chancellor, the University of the Punjab, Lahore.

VICE-CHAIRMEN:

1. The Hon'ble S.B. Sir Sundar Singh Majithia, C.I.E.
2. The Hon'ble Rao Bahadur Ch. Sir Chhotu Ram.
3. The Hon'ble Mian Abdul Haye.
4. The Hon'ble Major Nawabzada Malik Khizar Hayat Khan Tiwana, O.B.E.
5. The Hon'ble Rai Bahadur Lala Ram Saran Das, C.I.E., M.C.S.
6. G. Kaula, Esq., C.I.E., Representative, Maharaja Jind.
7. Mr. W. H. F. Armstrong, M.A., I.E.S., Director of Public Instruction.
8. Dr. S. S. Bhatnagar, O.B.E., D.Sc., F.Inst.P.Dir.
9. Jagan Nath Aggarwal, Esq., M.A., LL.B. (Advocate).

LOCAL SECRETARY:

Diwan Anand Kumar, M.A., M.Sc., Reader of Zoology, the Punjab University, Lahore.

JOINT LOCAL SECRETARIES:

Dr. Haraprasad Chaudhuri, D.Sc., Ph.D., D.I.C., F.N.I., Head of the Department of University Teaching in Botany, the Punjab University, Lahore.

Prof. J. M. Benade, M.A., Professor of Physics, Forman Christian College, Lahore.

MEMBERS OF THE LOCAL RECEPTION COMMITTEE:

Dewan Bahadur Raja Narindra Nath.
G. C. Chatterji, Esq., M.A., I.E.S.
Rai Bahadur Binda Saran.
S. Charan Singh, M.Sc.
Minhaj-ud-Din, B.A., M.Sc.
Mohd. Fazal, Esq., M.A.
C. V. H. Rao, Esq., M.A.
Dr. J. N. Ray, Ph.D., D.Sc., F.I.C.
Dr. N. K. Bose.
Dr. A. N. Puri.
Dr. Mackenzie Taylor.
Dr. S. L. Ghose, M.Sc., Ph.D., F.L.S.
Dr. P. K. Kitchlew, D.Sc.
Ganga Ram Kohli, Esq., M.Sc.
Rai Sahib Lala Gopal Das, M.L.A.
Lala Roop Chand.
M. C. Sethi, Esq.
Khan Bahadur Mian Ahmed Yar Khan Daulatana, M.L.A.
Rai Bahadur Balak Ram Panday.
J. W. Thomas, Esq.
Mehar Chand, Esq.

Dr. G. L. Datta, M.A., Ph.D.
Khan A. Rahman, Esq., Ph.D.
Rai Bahadur Dr. Jiwan Lal, M.D., B.S.
Dr. Rev. E. D. Lucas, M.A., Ph.D., D.D.
Govind Dass Bhagat, Esq.
S. Mahan Singh, M.Sc.
Dr. B. L. Bhatia, D.Sc.
Lt.-Col. S. N. Hayes, I.M.S.
R. N. Parkar, Esq.
Balak Ram, Esq., Bar.-at-Law.
Dr. A. H. Butt.
Nawazish Ali Qazalbash, Esq., M.Sc.
M. A. Ghani, Esq., M.A.
P. R. Bence Jones, Esq.
W. R. Jones, Esq., B.Sc.
S. M. Sharif, Esq.
Rai Bahadur Lala Ishwar Das, M.A., LL.B.
Lala Mehar Chand Mahajan.
Rai Bahadur Bawa Natha Singh.
Major B. S. Nat, I.M.S.
Lt.-Col. P. B. Bharucha, I.M.S.
Diwan Hari Kishan Dass.
Dr. N. A. Yajnik.
Captain Elahi Bakhsh, I.M.S.
Lt.-Col. H. S. Anand, I.M.S.
Dr. Manmohan Singh, P.C.M.S.
S. P. Singha, Esq., M.A., LL.B., M.L.A.
Sardar Bahadur S. Prabh Singh Chawala.
Dr. S. D. Muzzaffar, M.A., M.Sc., Ph.D., F.R.S.A.
D.B. Dewan Krishan Kishore.
Diwan Khem Chand.
Prof. P. C. Carter Speers.
Sardar Fateh Singh.
Principal Sewa Ram Suri.

4. GENERAL.

The Twenty-sixth Meeting of the Indian Science Congress Association was held at Lahore from January 2nd to January 8th, 1939.

The inaugural meeting was held on Monday, January 2nd, 1939 at 12-30 P.M. in the University Hall, Lahore, in the presence of the Patron, His Excellency Sir Henry Duffield Craik, Bart., K.C.S.I., I.C.S., the Governor of the Punjab. Khan Bahadur Mian M. Afzal Husain, M.A., M.Sc., F.N.I., Vice-Chancellor, the University of the Punjab, Chairman of the Reception Committee, welcomed the delegates and requested His Excellency the Governor of the Punjab to open the Congress. His Excellency opened the Congress with a speech and then the President of the Congress, Prof. J. C. Ghosh, D.Sc., F.N.I., delivered his address. Professor J. N. Mukherjee, D.Sc., F.C.S., F.R.A.S.B., F.N.I., General Secretary, thanked His Excellency for the trouble he had taken in opening the Congress.

The Sectional Presidential Addresses were delivered as follows:—

Tuesday, January 3rd: 10 A.M., Agriculture; 11 A.M., Zoology; 12 noon, Botany.

Wednesday, January 4th: 10 A.M., Geography and Geodesy; 11 A.M., Geology.

Friday, January 6th: 10 A.M., Mathematics and Physics; 11 A.M., Psychology; 12 noon, Physiology.

Saturday, January 7th: 10 A.M., Chemistry; 11 A.M., Anthropology; 12 noon, Medical and Veterinary Research.*

Symposia and Joint Meetings of Sections were held as follows:—

Tuesday, January 3rd: 11 A.M.–12-30 P.M., (1) Discussion on 'The Structure of Liquids', Section of Mathematics and Physics; (2) Discussion on 'Place of Physiology in General Education', Section of Physiology; (3) Discussion on 'The Rôle of the Modern Geographer in India', Section of Geography and Geodesy.

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* The Presidential Address was fixed for delivery on Wednesday, January 4th, but the date was changed at the special request of the Sectional President.

Wednesday, January 4th: 11 A.M.–12-30 P.M., (1) Discussion on 'Zoogeography in India', Section of Zoology; (2) Discussion on 'Psychology in the Service of Education in India', Section of Psychology; (3) Discussion on 'The Application of the Statistical Methods in Anthropology', Section of Anthropology held in co-operation with the Indian Statistical Conference; 1-30 P.M.–3 P.M., (4) Joint Meeting of the Sections of Agriculture, Physics, Medical and Veterinary Research, Geography and Geodesy held in co-operation with the Indian Society of Soil Science and the National Institute of Sciences of India to discuss 'Erosion and Drainage Problems in India'.

Friday, January 6th: 11 A.M.–12-30 P.M., (1) Discussion on 'Theoretical Statistics', Section of Mathematics and Physics held in co-operation with the Indian Statistical Conference; (2) Joint Meeting of the Sections of Agriculture, Botany, Zoology held in co-operation with the Society of Biological Chemists, India, to discuss 'Disease and Pest Resistance in Crops'; 1-30 P.M.–3 P.M., (1) Joint Meeting of the Sections of Agriculture and Medical and Veterinary Research held in co-operation with the Society of Biological Chemists, India, to discuss 'Composts', (2) Joint Meeting of the Sections of Geography and Geodesy, Geology, Mathematics and Physics (for Meteorologists), Botany and Zoology to discuss 'A Need for Uniformity in the Physiographic Divisions of India'; (3) Joint Meeting of the Sections of Psychology and Anthropology to discuss 'Factors determining Changes in Religious Phenomena'.

Saturday, January 7th: 11 A.M.–12-30 P.M., Discussion on 'Experimental Field Trials', Section of Agriculture held in co-operation with the Indian Statistical Conference; 2 P.M.–3-30 P.M., (1) Discussion on 'Application of the Statistical Method in Medicine', Section of Medical and Veterinary Research held in co-operation with the Indian Statistical Conference; (2) Joint Meeting of the Sections of Anthropology and Psychology to discuss 'Social Disorganization'.

Sunday, January 8th: 10 A.M.–11-30 A.M.: (1) Joint Meeting of the Sections of Geography and Geodesy, Agriculture, Botany, Mathematics and Physics (for Meteorologists) and Zoology (for Entomologists) to discuss 'The Agricultural Cycle'; (2) Discussion on 'Scope of

Private Enterprise in Archæological and Anthropological Research in India', Section of Anthropology.

Special Lectures and Demonstrations were arranged as follows:—

Tuesday, January 3rd: 3 P.M., Lecture on 'Control of Capacity of Circulation' by Prof. R. J. S. McDowall, Department of Physiology, King's College, University of London.

Wednesday, January 4th: Half an hour's exposition of Sir Shah Sulaiman of his theory about 'Unification of Gravitation and Electricity' in the Section of Mathematics and Physics; 2 P.M.–5 P.M., Demonstration of physiological experiments including 'a method for recording the rate and depth of respiration in rabbits' by Dr. S. A. Rahman.

Popular Lectures were delivered as follows:—

Tuesday, January 3rd: 6-30 P.M., 'Beyond the Stratosphere' by Prof. S. K. Mitra, M.B.E., D.Sc., F.N.I., Sir Rashbehari Ghosh Professor of Physics, University of Calcutta, Calcutta.

Wednesday, January 4th: 6-30 P.M., 'Plastic Materials and Their Uses' by Dr. H. K. Sen, M.A., D.Sc., D.I.C., Director, Indian Lac Research Institute, P.O. Namkum, Ranchi.*

Friday, January 6th: 6-30 P.M., 'Indian Domestic Animals' by Dr. B. Prashad, D.Sc., F.R.S.E., F.L.S., F.Z.S., F.N.I., F.R.A.S.B., Director, Zoological Survey of India, Indian Museum, Calcutta.

Saturday, January 7th: There was no lecture, as Mr. N. C. Mehta, I.C.S., could not attend the Session to deliver his lecture on 'The Pictorial Art of the Punjab'.

The following Functions and Entertainments were held in honour of the Members of the Indian Science Congress:—

Tuesday, January 3rd: 8 P.M., Oxford and Cambridge and London Subscription Dinners.

Wednesday, January 4th: 4-15 P.M., Garden Party by the Chairman and Vice-Chairman of the Reception Committee at the Nedous' Hotel.

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* Prof. K. G. Naik, D.Sc., F.I.C., F.N.I., having been unable to attend the Session to deliver his lecture on 'At the Threshold of Industrialisation'.

Friday, January 6th: 3-45 P.M., Government House 'At Home'; 9-30 P.M., Variety Entertainment (organized by Lahore Arts Circle).

Saturday, January 7th: 8-15 P.M., Science Congress Dinner.

The following Visits and Excursions were arranged for Members of the Indian Science Congress Association:—

Monday, January 2nd: 2-30 P.M., Arrangements were made for local sight-seeing by buses: Mainly the following places were visited—Shalimar Gardens, the Fort and the Palace, the Badshahi Mosque, Ranjit Singh's Samadh (Tomb), Hazuri Bagh, Shahdara, Mausoleum of Asaf Khan, Rauza (Tomb) of Nur Jahan, Baradari of Mirza Kamran, Tomb of Anarkali, Chauburji.

Tuesday, January 3rd: 2-30 P.M., Trip to Golden Temple, Amritsar: On the way the delegates got down at the Shalimar Gardens and Khalsa College. The Students and Professors of the Khalsa College invited the party at tea: The party left the College at 5-30 P.M. for Golden Temple and after the visit the party reached Lahore at 9-30 P.M.

Wednesday, January 4th: 2 P.M., Arrangements were made for local sight-seeing by buses.

Thursday, January 5th: Whole day excursions: (1) Excursion to Taxila. The party left Lahore by train at night on January 4th, and arrived back on the early morning of January 6th. (2) Excursion to Agricultural College, Lyallpur. The party left Lahore by motor car on Thursday, January 5th at 7-30 A.M., also visited the Ganesh Flour Mills Ltd., and Delhi Cotton Mills Ltd., at Lyallpur, and returned to Lahore the same day in the evening. (3) Excursion to New Egerton Woollen Mills, Dhariwal. The party left Lahore by motor car on Thursday, January 5th at 8 A.M., visited some factories at Amritsar on the way back, and reached Lahore the same evening.

Saturday, January 7th: 11-50 P.M., Excursion to Khewra Salt Mines. The excursion was arranged by the Section of Geography and Geodesy.

THE SECTIONAL COMMITTEES met at (1) 2-30 P.M. on Monday, January 2nd; (2) 9-30 A.M. on Tuesday, January 3rd; (3) 9-30 A.M., on Wednesday, January 4th; (4) 9-30 A.M. on

Friday, January 6th; (5) 9-30 A.M. on Saturday, January 7th; (6) 9-30 A.M. on Sunday, January 8th.

THE COUNCIL met at 3-30 P.M. on Monday, January 2nd, 1939.

THE EXECUTIVE COMMITTEE met at (1) 9 P.M. on Tuesday, January 3rd; (2) 3-30 P.M. on Sunday, January 8th.

THE GENERAL COMMITTEE met at (1) 2-30 P.M. on Friday, January 6th *; (2) 2-30 P.M. on Sunday, January 8th.†

The following Scientific Societies held their Annual Meetings during the Twenty-sixth Session of the Congress:—

1. The Annual Meeting of the National Institute of Sciences of India, held at 5 P.M. on Monday, January 2nd, 1939.
2. The Annual Meeting of the Indian Society of Soil Science, held at 3 P.M. on Wednesday, January 4th, 1939.
3. The Annual Meeting of the Entomological Society of India, held at 3 P.M. on Wednesday, January 4th, 1939.
4. The Annual Meeting of the Indian Physical Society, held at 3 P.M. on Wednesday, January 4th, 1939.
5. The Annual Meeting of the Indian Statistical Conference, held at 11 A.M. on Thursday, January 5th, 1939.
6. The Annual Meeting of the Society of Biological Chemists, India, held at 5-30 P.M. on Friday, January 6th, 1939.
7. The Annual Meeting of the Indian Chemical Society, held at 3 P.M. on Saturday, January 7th, 1939.
8. The Annual Meeting of the Physiological Society of India, held at 3 P.M. on Saturday, January 7th, 1939.
9. The Annual Meeting of the Indian Botanical Society, held at 3 P.M. on Saturday, January 7th, 1939.
10. The Annual Meeting of the Indian Psychological Association, held at 4 P.M. on Saturday, January 7th, 1939.
11. The Annual Meeting of the Institute of Chemistry of Great Britain and Ireland (Indian Section), held at 4 P.M. on Saturday, January 7th, 1939.

The inaugural meeting of the Zoological Society of India, held at 3 P.M. on Saturday, January 7th, 1939.

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* The meeting was adjourned at 3-30 P.M. in order to enable the members to join the party at the Government House.

† A special meeting of the General Committee was convened to discuss 'Science and its Social Relations' at 9 P.M. on Friday, January 6th, but was adjourned for unavoidable reasons. The subject was discussed by the General Committee at their adjourned meeting held at 2-30 P.M. on Sunday, January 8th, 1939.

5. OPENING PROCEEDINGS.

The Twenty-sixth Meeting of the Indian Science Congress was opened on Monday, January 2nd, 1939 at 12-30 P.M. by His Excellency Sir Henry Duffield Craik, Bart., K.C.S.I., I.C.S., Governor of the Punjab, at the University Hall, Lahore, in the presence of the Hon'ble Khan Bahadur Major Sirdar Sir Sikandar Hayat Khan, K.B.E., the Premier of the Government of the Punjab, and a large gathering of delegates, members and visitors. Seats were specially reserved for the President, Past Presidents, Sectional Presidents, the Local Secretary, the Joint Local Secretaries, the General Secretaries, the Chairman, Local Reception Committee, and Special Delegates from Universities and Learned Societies. Khan Bahadur Mian M. Afzal Husain, M.A., M.Sc., Vice-Chancellor of the University and Chairman of the Local Reception Committee, welcomed the delegates and visitors in a short speech and invited His Excellency the Governor of the Punjab to open the Session of the Congress.

His Excellency the Governor of the Punjab then addressed the meeting as follows:—

MR. VICE-CHANCELLOR, MR. PRESIDENT AND DELEGATES:

It is now just 12 years since the Science Congress met in Lahore and I need hardly say with what pleasure we, in the Punjab, welcome you to this Province again. Your last meeting here gave a notable stimulus to interest in scientific research. Since 1927 rapid strides have been made by the various science departments of the Punjab University. The number of research students has considerably increased and in some cases has been more than doubled. There has been also a much greater output of written work, notably in Physics and Chemistry, while the Chemistry Department, under the distinguished direction of Professor Bhatnagar, has attracted students from all parts of India, and its achievements have won recognition in Europe also. It would be presumptuous for me, educated as I was at a time when science had scarcely established its claim to be a serious subject for school study, to attempt to describe, or even to name, the particular fields of research in which Professor Bhatnagar and his assistants have obtained decisive success; but I understand that their work is of both practical and academic importance. On the practical side, science is being applied to industry with a view to making the fullest and most profitable use of all the natural products of the Punjab, and such is felt to be the commercial value of Professor Bhatnagar's work that English firms have placed at his disposal large sums for the prosecution of his investigations. On the academic side, the researches which have been made into the magnetic properties of atoms and molecules with the object of revealing the nature of chemical bonds and the control of chemical reactions are, I believe, of a fundamental character.

With the ever-increasing demand for the development and industrialization of this country, the need for Applied Science requires no emphasis. It is as great and greater now than it was in 1927. I think we may claim that we, in the Punjab, are playing our part. In no Province of India has so great practical recognition been given to the dependence of agricultural progress on systematic research. Our agricultural laboratories at Lyallpur are already famous, while our Irrigation Research branch, under the direction of Dr. McKenzie-Taylor, is engaged in experiments in many ways quite unique.

But there is another thought which I should like to suggest to you. It is that the need for India to contribute also to scientific research of a less obviously utilitarian character, to produce a band of workers eager to extend the boundaries of human knowledge, and to devote their lives to the quest of truth is greater to-day than ever before. For, if we survey the world as a whole, we must admit that the atmosphere is now much less favourable to the true scientific spirit than it was even as recently as 12 years ago. It is hardly overstating the case when I say that over large areas some of the ablest intellects now devote their energies to the deliberate dissemination of falsehood in preference to the disinterested search for truth. The old ideals of a liberal and humane education have been abandoned. To the teachers who sought to inspire in their pupils a love of truth and a suppleness of mind, responsive to evidence and argument, have succeeded propagandists, whose object is not the telling of truth, and the weighing and testing of various points of view, but the exclusive emphasizing of one.

It is strange to reflect that modern science which began as revolt against religious dogma, is now after four centuries, being invoked as authority for dogmas, no less narrow than those which it displaced. The foundation of the Royal Society was, you may remember, encouraged by King Charles II as a cure for the fanatical religious creeds with which Europe was, at that time, distracted. It was hoped that the scientific habit of mind would produce a healthy scepticism and make people less anxious to martyr one another for their opinions. These hopes were, to a large extent, justified. The violent conflicts of the seventeenth century have been followed by more than 200 years of toleration and enlightenment, during which the human mind has made more striking conquests of the world of nature than in any other known period of history. But now once again mankind seems to be falling a prey to dogma, and where the dogmatic spirit prevails, all branches of intellectual life are stunted and distorted;

science, prostituted at the bidding of a mean utilitarianism, receives her orders from the politician and her name is taken in vain as authority for, it may be, some untested biological theory, some unproved doctrine of social or economic development or some form of materialist philosophy about which science ought not to profess to speak.

But India still remains one of those portions of the globe where the old ideals have not yet been definitely repudiated and where the disinterested pursuit of truth is still possible. It is therefore all the more necessary that this country should produce scientists prepared to devote themselves to the single-minded quest of truth to replace those who in other countries are compelled to accept as truth only those dogmas which their rulers are pleased to enjoin.

I am afraid I may have already over-taxed your patience, but before asking your attention to the opening address of your distinguished President, may I quote to you a passage from a writer which seems to me to breathe a temper worthy of the true scientist—a temper in which a love of truth and humility of mind is combined with deep sympathy for man and a desire to serve him. Francis Bacon, standing at the threshold of the modern age, foresaw the triumphs of modern science and heralded the dawn of man's hitherto unimagined empire over the forces of nature. With prophetic insight he divined that the world was on the brink of a vast revolution of thought and achievement which might bring incalculable blessings; and he felt that this great change was being delayed onyl through man's enslavement to authority and dogma. In the passage which I have in mind, after inveighing against the dogmatic spirit prevalent in the learned circles of his time and complaining that authority is taken for truth, and not truth for authority, he proceeds to state in noble and moving words the thought which I am endeavouring to emphasize—'If, therefore (he says), there be any humility towards the Creator, any reverence for or disposition to magnify His works, any charity for man and anxiety to relieve his sorrows and necessities, any love of truth in nature, any hatred of darkness, any desire for the purification of the understanding, we must entreat men again and again to discard, or at least set apart for a while, these volatile and preposterous philosophies which have preferred theses to hypotheses, led experience captive, and triumphed over the works of God; and to approach with humility and veneration to unroll the volume of Creation, to linger and meditate therein, and with minds washed clean from opinions to study it in purity and integrity. For this is that sound and language which "went forth into all lands", and did not incur the confusion of Babel, this should men study to be perfect in, and becoming again as little children condescend to take the alphabet of it into their hands, and spare no pains to search and unravel the interpretation thereof, but pursue it strenuously and persevere even unto death.'

I now have pleasure in declaring this Congress open, and in calling upon Dr. Ghosh to deliver his presidential address.

At the end of His Excellency the Governor's speech, the President, Professor J. C. Ghosh, delivered his address.*

The meeting terminated with votes of thanks to His Excellency the Governor of the Punjab and to the Local Reception Committee proposed by Professor J. N. Mukherjee, D.Sc., F.C.S., F.R.A.S.B., F.N.I., the General Secretary.

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* Published in Part II of the Proceedings.

6. OFFICIAL.

A. DELEGATE FROM THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Dr. A. M. Heron.

B. DELEGATES FROM UNIVERSITIES, LEARNED SOCIETIES, COLLEGES, STATES AND GOVERNMENT DEPARTMENTS IN INDIA.

Agra University.

1. Mr. Shiv Raj Bahadur.
2. Rai Bahadur Dr. K. C. Mehta.
3. Dr. S. K. Mukerji.
4. Mr. Ram Prasad.
5. Dr. B. L. Rawat.

Aligarh Muslim University.

1. Dr. Omar Farooq.
2. Dr. S. M. Tahir Rizvi.

University of Allahabad.

1. Prof. A. C. Banerji.
2. Dr. S. B. Dutt.
3. Dr. Haru Ram Mehra.
4. Dr. J. H. Mitter.

Andhra University.

1. Dr. G. Gopala Rao.
2. Dr. I. Ramakrishna Rao.
3. Mr. N. L. Vidyarthi.

Benares Hindu University.

1. Dr. Y. Bharadwaja.
2. Dr. B. Dasannacharya.
3. Dr. V. S. Dubey.
4. Dr. N. N. Godbole.
5. Dr. A. C. Joshi.
6. Dr. S. S. Joshi.
7. Dr. A. B. Misra.
8. Prof. V. V. Narlikar.
9. Dr. Rajnath.
10. Prof. M. L. Schroff.
11. Dr. B. N. Singh.
12. Prof. P. S. Varma.

University of Bombay.

1. Dr. K. G. Naik.
2. Dr. N. R. Tawade.
3. Dr. K. Venkataraman.

University of Dacca.

1. Dr. T. P. Banerjee.
2. Prof. S. N. Bose.
3. Dr. K. P. Basu.
4. Prof. N. M. Basu.
5. Mr. H. D. Bhattacharyya.
6. Dr. J. K. Choudhury.
7. Dr. S. S. Guha Sarkar.
8. Mr. Sachindra Mohan Mitra.
9. Dr. M. C. Nath.
10. Dr. S. P. Ray-Chaudhury.
11. Dr. T. Vijayaraghavan.

University of Delhi.

1. Dr. D. S. Kothari.
2. Dr. B. D. Loroia.
3. Dr. Indra Sen.

University of Lucknow.

1. Dr. W. Burridge.
2. Mr. C. D. Chatterji.
3. Dr. S. N. Das Gupta.
4. Dr. D. N. Majumdar.
5. Dr. S. N. Mathur.
6. Dr. S. K. Pande.
7. Mr. Kali Prasad.
8. Dr. Ram Narain Saksena.
9. Dr. N. N. Sen Gupta.
10. Mr. L. N. Srivastava.
11. Mr. R. S. Varma.

University of Madras.

1. Sri R. Gopala Aiyar.
2. Sri B. M. Tirunaranan.
3. Sri R. Vaidyanathaswami.

Nagpur University.

1. Dr. S. C. Dhar.
2. Dr. A. N. Kappanna.
3. Dr. M. A. Moghe.
4. Dr. R. L. Nirula.
5. Dr. V. N. Thatte.

Osmania University.

1. Dr. B. K. Das.
2. Dr. Syed Husain.
3. Dr. Brij Mohan Lal.
4. Dr. Muzaffaruddin Qureshi.
5. Mr. Rahimullah.
6. Dr. Syed Abdul Rahman.
7. Prof. M. Sayeeduddin.
8. Dr. D. D. Shendarkar.
9. Dr. Raziuddin Siddiqi.
10. Dr. Nazir Ahmad Tahir.

Patna University.

1. Mr. Qamrud Doja.
2. Mr. Basudeva Narayan.

University of Rangoon.

1. Dr. J. Farquharson.

Trivandrum University.

1. Dr. K. L. Moudgill.
2. Dr. H. Subrahmonia Ayyar.

National Academy of Sciences, India.

1. Prof. A. C. Banerji.
2. Dr. D. S. Kothari.
3. Dr. H. R. Mehra.
4. Prof. J. H. Mitter.
5. The Hon'ble Sir Shah Muhammad Sulaiman.

Royal Institute of Science.

1. Prof. F. R. Bharucha.

Fergusson College.

1. Dr. D. D. Karve.

Gawlior State.

1. Mr. Ram Prasad.

The Government of Bombay.

1. Mr. R. L. A. Alimchandani.
2. Mr. J. J. Asana.
3. Dr. F. R. Bharucha.
4. Dr. Mata Prasad.
5. Dr. R. C. Shah.

C. FINANCIAL ARRANGEMENTS FOR THE TWENTY-SIXTH SESSION.

THE LOCAL RECEPTION COMMITTEE.

The Local Reception Committee made all local arrangements necessary for the transaction of the scientific work of the meeting and all local arrangements regarding social functions and accommodation of the members of the Congress and the delegates.

In addition to the usual arrangements, e.g. supplying informations regarding accommodation, arrival and departure of trains, registration of accommodation in hotels, etc., the Local Reception Committee specially arranged for the accommodation of the delegates from abroad as guests of members of the Local Reception Committee and their friends.

Financial arrangements for the Session were made by the Local Committee.

D. MEETINGS OF THE GENERAL COMMITTEE, THE COUNCIL AND THE EXECUTIVE COMMITTEE OF THE INDIAN SCIENCE CONGRESS ASSOCIATION.

1. MEETING OF THE GENERAL COMMITTEE.

A meeting of the General Committee was held at 2-30 P.M. on Friday, January 6th, 1939, in the Hailey Hall, Lahore, with Prof. J. C. Ghosh, D.Sc., F.N.I., the President, in the chair. The following items of business were transacted:

(1) The minutes of the proceedings of the last meeting held on January 8th, 1938, in the Senate Hall, Calcutta, were read and confirmed.

(2) The President announced the following names of five Ordinary Members elected to the Executive Committee under Rule 13, and of five Ordinary Members elected to the Council under Rule 17 for the year 1939-40:

Executive Committee.	*Council.*
1. Prof. S. P. Agharkar.	1. Prof. S. N. Bose.
2. Prof. S. S. Bhatnagar.	2. Prof. S. R. Bose.
3. Prof. S. K. Mitra.	3. Bt.-Col. R. N. Chopra.
4. Prof. M. N. Saha.	4. Prof. K. L. Moudgill.
5. Rao Bahadur T. S. Venkatraman.	5. Prof. G. R. Paranjpe.

(3) The President announced that the Twenty-seventh Meeting of the Indian Science Congress will be held in Madras under the auspices of the Madras University.

(4) The President announced the names of the Sectional Presidents and Recorders of the Twenty-seventh Meeting as follows:

	Section.	*President.*	*Recorder.*
1.	*Mathematics and Physics.*	Prof. K. S. Krishnan	Prof. A. C. Banerji.*
2.	*Chemistry*	Dr. S. Krishna	Dr. Syed Husain.
3.	*Geology*	Prof. L. Rama Rao	Dr. C. Mahadevan.
4.	*Geography and Geodesy.*	Dr. S. P. Chatterjee	Mr. George Kuriyan.
5.	*Botany*	Prof. Y. Bharadwaja	Dr. K. Biswas.†
6.	*Zoology*	Prof. B. K. Das	Mr. Beni Charan Mahendra.
7.	*Anthropology*	Rao Bahadur K. N. Dikshit.	Capt. R. N. Basu.
8.	*Medical and Veterinary Research.*	Dr. J. R. Haddow	Dr. K. V. Krishnan.‡

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* After the separation of the Section of Mathematics Prof. A. C. Banerji has been appointed the President of this Section and Prof. Kamta Prasad has been appointed the Recorder of the Section of Physics.

† Dr. K. Biswas having declined Dr. F. R. Bharucha has been appointed the Recorder of the Section.

‡ Dr. K. V. Krishnan having declined Dr. C. G. Pandit has been appointed the Recorder of the Section.

	Section.	*President.*	*Recorder.*
9.	*Agriculture*	Dr. E. McKenzie-Taylor.*	Dr. C. N. Acharya.
10.	*Physiology*	Dr. W. R. Aykroyd	Dr. B. B. Dikshit.
11.	*Psychology*	Dr. D. D. Shendarkar	Dr. I. Latif.

(5) In confirmation of the nomination made by the Executive Committee Prof. B. Sahni, M.A., Sc.D., D.Sc., F.R.S., F.N.I., was appointed the General President for the year 1940.

(6) In confirmation of the nomination made by the Executive Committee Mr. P. Parija, M.A., F.N.I., I.E.S., was appointed a General Secretary (vice Mr. W. D. West resigned) for a period of five years from February 1st, 1939 to January 31st, 1944.

(7) The following recommendations of the Executive Committee were considered and the action taken on them are recorded below under each item:

(*a*) 'The Section of Mathematics and Physics be separated into two independent Sections.'

Resolved that the recommendation be accepted.

(*b*) 'The Executive Committee is generally in favour of the proposal of separating Medical and Veterinary Research into two separate Sections specially in view of the development of the study of animal genetics and animal nutrition but is of opinion that the suggestion made by Mr. F. Ware that the Indian Science Congress should form a new Section entitled "Veterinary and Dairy Research" should be reconsidered by the Sectional Committee and the Council.'

It was decided to refer the matter back to the Executive Committee with recommendation that further possible regrouping of subjects into Sections should also be considered.

(*c*) 'In view of the growth of the subject of Entomology in India and the number of abstracts received for publication in 1938 the Executive Committee recommends to the General Committee that an independent Section of Entomology be formed.'

Resolved that the recommendation be accepted.

(8) Considered the proposals received from Prof. B. K. Das, Dr. H. P. Chaudhuri, Dr. S. L. Hora for alterations to the rules and regulations of the Association and the resolutions of the Executive Committee adopted in this regard and other related matters.

(*a*) Resolution No. 1 proposed by Prof. B. K. Das, which is same as Resolution No. 2 proposed by Dr. S. L. Hora, is as follows:

'That the election of the Sectional Presidents should be done by the postal vote of all the members of the Sectional Committee, including those absent from the meeting, as is done in the case of the election of the five Ordinary Members to the Executive Committee and the five Ordinary Members to the Council.'

RECOMMENDATION OF THE EXECUTIVE COMMITTEE.

'Regarding the resolutions proposed by Prof. B. K. Das and Dr. S. L. Hora regarding the manner of election of the Sectional Presidents, it was resolved that Regulation I(8) be deleted and the following substituted in its place:

(i) Early in November copies of a printed form will be issued to Presidents of Sections for circulation to members of the Sectional Committees requesting them to nominate a

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* Since Dr. McKenzie-Taylor could not accept the office Prof. J. C. Luthra has been appointed the President of this Section.

President and a Recorder for the ensuing meeting for consideration by the Sectional Committee. Such proposals shall be accompanied by a statement of qualifications of the nominees for the office and their willingness to accept the same if elected thereto.

(ii) During the first week of December, the President of each Section shall circulate all such proposals received by him, together with the statements of qualifications, to the members of the Sectional Committee and request them to nominate by ballot one member for each office from among the list circulated, the ballot papers being received by him up to the 20th December.

(iii) At the first meeting of the Sectional Committee held on the Opening Day, the ballot papers shall be opened and scrutinized as the Chairman shall direct and the result communicated to the Executive Committee for consideration, together with a complete record of the Proceedings in this connection.

Resolved further that the last paragraph of Rule 29 be deleted as a consequential change.'

Resolved that the recommendation of the Executive Committee be approved.

(*b*) Resolution No. 2 proposed by Prof. B. K. Das is as follows:

'That the acceptance and refereeing of papers should be done by a board of referees consisting of three members elected by the Sectional Committee, and that any refusal in acceptance of the papers should be always accompanied by reasons for so doing, as done in International Congress.'

RECOMMENDATION OF THE EXECUTIVE COMMITTEE.

'Regarding the above resolution suggesting the appointment of a board of referees and the question of giving reasons for refusal of a paper, it was resolved that necessary provision has already been made in Rule 30(*c*) and that further elaboration is not feasible on practical grounds. It was also resolved that it is not advisable to assign reasons for the refusal of papers.'

Resolved that the recommendation of the Executive Committee be approved.

(*c*) Resolution No. 1 proposed by Dr. H. P. Chaudhuri is as follows:

'That Rule 13 of the Rules and Regulations of the Indian Science Congress Association, line 6 be read "seven Ordinary Members elected by the General Committee" instead of "five Ordinary Members elected by the General Committee".'

RECOMMENDATION OF THE EXECUTIVE COMMITTEE.

'Regarding the Resolution proposed by Dr. H. P. Chaudhuri intending to modify Rule 13 so as to increase the number of Ordinary Members elected by the General Committee from 5 to 7, it was resolved that while a small Executive Committee is more suitable for the expeditious handling of the affairs of the Association it is, however, felt that in view of the increase in membership of the Association the proposal should be accepted.

It is also pointed out that Dr. Chaudhuri's statement regarding the number of elected members of the Executive Committee is not formally correct as the nominations for the offices of the General President, President-elect and the General Secretaries made by the Executive Committee are subject to the confirmation of the General Committee (*vide* Rules 19 and 20).'

Resolved that the recommendation of the Executive Committee be approved.

(*d*) Resolution No. 2 proposed by Dr. H. P. Chaudhuri is as follows:

> 'That in Rule 13, lines 10 to 12, and in Rule 17, lines 10 to 12, be read " the Executive Committee shall circulate these names to all Ordinary Members for election by ballot " instead of " the Executive Committee shall circulate these names together with such other names not exceeding three as it may suggest to all Ordinary Members for election by ballot ".'

RECOMMENDATION OF THE EXECUTIVE COMMITTEE.

'Regarding Dr. Chaudhuri's second resolution suggesting that the Executive Committee should not be empowered to nominate other names not exceeding three as provided for in the existing Rule 13, lines 10 to 12, and Rule 17, lines 10 to 12, it was decided that the Executive Committee should retain the power of adding not more than three names to the nominations for election to the Executive Committee and to the Council in order to ensure adequate representation of all interests. It was also decided to make clear to Dr. Chaudhuri that the ballot papers do not in any way indicate the nomination made by the Executive Committee.'

Resolved that the recommendation of the Executive Committee be accepted.

(*e*) Resolution No. 3 proposed by Dr. H. P. Chaudhuri is as follows:

> 'That in Rule 27, lines 2 to 4, be read "in addition there shall be a Sectional Correspondent and a Local Sectional Secretary who shall be appointed by the Sectional Committee" instead of "in addition there shall be a Sectional Correspondent and a Local Sectional Secretary who shall be appointed by the Executive Committee".'

RECOMMENDATION OF THE EXECUTIVE COMMITTEE.

'Regarding the resolution proposed by Dr. Chaudhuri intending that the Sectional Correspondents and Local Sectional Secretaries shall be appointed by the relevant Sectional Committees instead of by the Executive Committee, which now make appointments of Sectional Officers, the Executive Committee is of opinion that the proposed change is not desirable on practical grounds.'

Resolved that the recommendation of the Executive Committee be accepted.

(*f*) Resolution No. 1 proposed by Dr. S. L. Hora is as follows:

> 'That the number of papers accepted for reading at Sections should be restricted to the number that can be dealt with in the time available and that in general the reading of papers should be subordinated to the holding of discussions.'

RECOMMENDATION OF THE EXECUTIVE COMMITTEE.

'At its meeting held on Monday, January 3rd, 1938, the Council requested the Executive Committee to appoint a Sub-committee to consider the general question " as to whether the time had not come when the present practice of accepting more papers than can be adequately dealt with at the Session of the Congress should be replaced by a more definitive programme in which discussion on problems of current research, and papers restricted to subjects of particular importance, should predominate ". This general question comprehends and covers the proposal of Dr. S. L. Hora. The Council considered the report of the Sub-committee at its meeting held on Monday, January 2nd, 1939.'

Resolved that the recommendation of the Executive Committee be approved.

(9) The audited accounts up to November 30th, 1938, were accepted.

(10) The following votes of thanks were unanimously adopted:

(*a*) A vote of thanks proposed by the President to H.E. the Governor of the Punjab for consenting to accept the Patronship of the Association and for opening the Session.

(*b*) A vote of thanks proposed by the President to the Hon'ble Khan Bahadur Major Sirdar Sir Sikandar Hayat Khan, K.B.E., Premier, the Government of the Punjab, for consenting to accept the Vice-Patronship of the Association.

(*c*) A vote of thanks proposed by the President to the University of the Punjab and its Vice-Chancellor.

(*d*) A vote of thanks proposed by the General Secretary, Prof. J. N. Mukherjee, to the Government of the Punjab.

(*e*) A vote of thanks proposed by the General Secretary, Prof. J. N. Mukherjee, to the Chairman and Members of the Local Reception Committee.

(*f*) A vote of thanks proposed by Prof. S. P. Agharkar to the Local Secretaries and the Volunteers.

(*g*) A vote of thanks proposed by the Vice-Chancellor of the University of the Punjab to the General Secretaries.

(*h*) A vote of thanks proposed by the Vice-Chancellor of the University of the Punjab to the President.

(*i*) A vote of thanks proposed by the Vice-Chancellor of the University of the Punjab to the Royal Asiatic Society of Bengal.

The meeting was then adjourned at 3-30 P.M. till 2-30 P.M. on Sunday, January 8th, 1939.

Adjourned Meeting of the General Committee.

(11) The following were elected members of the Sectional Committees for the year 1939-40:

Mathematics	1.	Dr. M. R. Siddiqi,* Hyderabad.
	2.	Dr. S. C. Dhar, Nagpur.
Physics	1.	Dr. P. K. Kichlu, Lahore.
	2.	Dr. I. Ramakrishna Rao, Waltair.
Chemistry	1.	Prof. B. Sanjiva Rao, Bangalore.
	2.	Prof. K. Venkataraman, Bombay.
Geology	1.	Dr. L. S. Krishnamurthi, Hyderabad.
	2.	Prof. A. S. Kalapesi, Bombay.
Geography and Geodesy	1.	Prof. M. B. Pithawala, Karachi.
	2.	Mr. V. D. Krishnaswami, Madras.
Botany	1.	Dr. P. L. Anand, Lahore.
	2.	Mr. K. A. Chowdhury, Dehra Dun.
Zoology	1.	Mr. M. M. Chakravarty, Calcutta.
	2.	Dr. A. B. Misra, Benares.
Entomology	1.	Mr. N. C. Chatterjee, Dehra Dun.
	2.	Dr. M. A. Narayan Rao, Madras.
Anthropology	1.	Prof. M. H. Krishna, Mysore.
	2.	Dr. P. C. Biswas, Calcutta.
Medical and Veterinary Research.	1.	Dr. J. N. Maitra, Calcutta.
	2.	Dr. C. G. Pandit, Guindy, Madras.
Agriculture	1.	Dr. L. A. Ramdas,† Poona.
	2.	Mr. N. L. Dutt, Coimbatore.

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* Later appointed Recorder of the Section of Mathematics.

† Declined.

Physiology	..	1. Prof. S. A. Rahman, Hyderabad.
		2. Dr. A. Subba Rao, Mysore.
Psychology	..	1. Dr. B. L. Atreya, Benares.
		2. Mr. Kali Prasad, Lucknow.

(12) Considered the following Regulations adopted by the Executive Committee:

(*a*) The accounts of the Association shall be audited once a year and the books closed on the 30th November each year for this purpose.

(*b*) The audited accounts shall be placed before the General Committee at the Annual Meeting with the observations, if any, of the Executive Committee.

(*c*) Sanction for all payments for amounts exceeding Rs.100 shall be obtained from the Finance Committee which shall consist of the General Secretaries, the Honorary Treasurer and one Ordinary Member resident in Calcutta who shall be nominated by the Executive Committee.

Resolved that the Regulations adopted by the Executive Committee be approved.

(13) Considered the following additions to and alterations in Rules and Regulations in that connection adopted by the Executive Committee:

'That

(*a*) In Rule 13 (i) delete the sentences within the brackets in lines 3, 4 and 5, (ii) delete the brackets, (iii) substitute the word "three" instead of the word "two" in the second line before the words "General Secretaries", and (iv) delete the words "the Managing Secretary" in line 4.

(*b*) In Rule 20, line 1, substitute the word "three" in place of the word "two" and add the following after the words "General Secretaries"—"two of whom shall be resident in Calcutta".

(*c*) Add a new Rule 21 after Rule 20 as follows: "There shall be a Treasurer who shall be nominated by the Executive Committee and whose nomination shall be submitted for confirmation to the General Committee at its Annual Meeting during the Session of the Congress".

(*d*) That consequential changes be made in the numbers of the existing rules succeeding Rule 20.

(*e*) In existing Rule 21 the words "and of the Treasurer" be inserted in the first line after the words "General Secretary".

(*f*) Substitute the words "General Secretary" in place of the words "Managing Secretary" in Regulations D(1) and D(5).'

Resolved that additions to and alterations in the Rules proposed by the Executive Committee be adopted.

(14) Considered the following additions to and alterations in Rules and Regulations adopted by the Executive Committee as modified by the Council:

'That

(*a*) All papers for reading at the Session of the Congress shall be checked by the Sectional Correspondent concerned or by such person or persons appointed by the General Secretary. The papers together with a copy of each of the abstracts shall then be sent to the Sectional President concerned for refereeing and acceptance.

(*b*) September 15th of the preceding calendar year be fixed as the last date for receipt by the General Secretary of papers and abstracts intended to be read at a session of the Congress provided that this date may be changed by the Executive Committee for special reasons.

(*c*) October 15th of the preceding calendar year be fixed for the receipt by the General Secretary of the Presidential Addresses to be delivered at a session of the Congress provided that this date may be changed by the Executive Committee for special reasons.

(*d*) Ordinarily the cost of printing 25 pages of Presidential Address shall be borne by the Indian Science Congress Association.'

Resolved that additions to and alterations in the Rules proposed by the Executive Committee and amended by the Council be adopted.

Resolved further that consequential changes in the Rules, Regulations, instructions to Sectional Officers and the application forms be made.

(15) Considered the following additions to and alterations in Rules and Regulations adopted by the Executive Committee as modified by the Council:

'That

(*a*) In future the Sectional Committees during the meeting of the Congress shall select topics for discussion at the next session of the Congress and make necessary arrangements: (i) through the President of the Section concerned for discussion within a Section, and (ii) through the Sectional President who has initiated the proposal for a discussion in which more than one Section will participate.

(*b*) The Sectional Presidents concerned shall communicate to the General Secretary before the end of July the titles of such discussions, the names of the speakers and such further information as may be considered necessary.

(*c*) The papers together with three copies of abstracts to be read by contributors at a discussion shall be sent to the General Secretary on or before the 15th September of the preceding calendar year by the Sectional President concerned.

(*d*) The materials relating to a discussion in a form ready for the Press shall be communicated by the Sectional President concerned to the General Secretary within a month from the date on which the discussion takes place and that material not received by the General Secretary within this period shall not be published.

(*e*) The President and the Recorder of the Section arranging a discussion shall carry out the necessary correspondence throughout the year during which they hold office.'

Resolved that the additions to and alterations in the Rules or Regulations proposed by the Executive Committee and amended by the Council be adopted.

Resolved further that a small allotment of money to the Presidents for correspondence be considered by the Executive Committee.

Resolved further that consequential additions and alterations be made in the Rules, Regulations and instructions to Sectional Officers.

(16) Considered the question of separation of the Office of the Association from the Royal Asiatic Society of Bengal and of having a permanent office staff of the Association.

Resolved that the resolution adopted by the Executive Committee and the Council in this matter be approved and that the Office of the Association be separated from the Royal Asiatic Society of Bengal and a permanent office staff be appointed.

Resolved further that in consequence of the separation of the work of the Association from the Royal Asiatic Society of Bengal the offices falling vacant in places of the ex-officio officers be filled up by the Executive Committee.

(17) Considered the following resolution of the Executive Committee:

> 'That in future if any Sectional President fails to send in his address before the 15th October, he shall cease *ipso facto* to be the President and the office held by him will be considered to have fallen vacant.'

Resolved that the principle adopted by the Executive Committee be approved generally.

2. SPECIAL MEETING OF THE GENERAL COMMITTEE.

A special meeting of the General Committee was convened at 9 P.M. on Friday, January 6th, 1939, to discuss the question of setting up an Indian Committee to work in Science and its Social Relations (C.S.S.R.) established by the International Council of the Scientific Unions, but was adjourned for unavoidable reasons. The matter was discussed at the adjourned meeting of the General Committee on Sunday, January 8th, 1939. It was decided to circulate a note on the subject to the members of the General Committee.

3. MEETING OF THE COUNCIL.

A meeting of the Council of the Indian Science Congress Association was held at 3-30 P.M. on Monday, January 2nd, 1939, in the Hailey Hall at Lahore, with Prof. J. C. Ghosh, D.Sc., F.N.I., the President, in the chair. The following items of business were transacted:

(1) The minutes of the proceedings of the meeting of the Council held on January 3rd, 1938, were read and confirmed.

(2) Considered the report of the Sub-committee appointed by the Executive Committee in accordance with the resolution of the Council at its meeting held on January 3rd, 1938, 'as to whether the time had not come when the present practice of accepting more papers than can be adequately dealt with at the Session of the Congress should be replaced by a more definitive programme in which discussion on problems of current research, and papers restricted to subjects of particular importance, should predominate'.

N.B.—The resolution of the Sub-committee is as follows:

> 'That the purpose in view will be best served by emphasizing in the instructions to the Sectional Officers and also, as far as relevant, in the letter issued by the Sectional President to intending authors the desirability of encouraging discussions within the Sections on topics of current importance. It is also desirable that the Sectional Presidents should draw up in consultation with the other Sectional Officers, a definite programme—with reference to past experience—of scientific work before each Section and adhere to it as far as practicable.'

Resolved that the resolution of the Sub-committee be approved generally.

(3) Considered the question of having a permanent office staff of the Association.

Resolved that the proposal be accepted and that the details be worked out by the Executive Committee.

(4) Considered the proposal from Dr. C. N. Acharya and the note by Prof. S. P. Agharkar regarding 'Science and its Social Relations'.

Resolved that the proposals contained in Prof. S. P. Agharkar's note be generally approved and that a committee consisting of the following members be appointed to make proposals to the Council in this connection:

1. The President.
2. The President-elect.
3. Prof. S. P. Agharkar (Convener).
4. Sir T. Vijayaraghavacharya.
5. Dr. C. N. Acharya.
6. The General Secretaries.

(5) Considered changes in the rules, etc. regarding last date for receipt of Abstracts of Papers and Presidential Addresses by the General Secretary and irregularities regarding acceptance of papers.

Resolved—

(*a*) that all papers submitted for reading at the Session of the Congress shall be checked by the Sectional Correspondent concerned or by such person or persons appointed by the General Secretary. The papers together with a copy each of the abstracts shall then be sent to the Sectional President concerned for refereeing and acceptance. Decisions with regard to acceptance or rejection of any paper shall be final and all reports confidential,

(*b*) that September 15th of the preceding calendar year be fixed as the last date for receipt by the General Secretary of papers and abstracts intended to be read at a Session of the Congress provided that this date may be changed by the Executive Committee for special reasons,

(*c*) that October 15th of the preceding calendar year be fixed as the last date for the receipt by the General Secretary of the Presidential Addresses to be delivered at a Session of the Congress provided that this date may be changed by the Executive Committee for special reasons,

(*d*) that ordinarily the cost of printing 25 pages only of a Presidential Address shall be borne by the Indian Science Congress Association.

Resolved further that consequential changes in the Rules, Regulations, instructions to the Sectional Officers and the application forms be made.

(6) Considered the resolutions adopted by the Executive Committee at its meeting held on December 14th, 1938, regarding the publication of discussions and regarding a last date after which no material should be received by the General Secretary.

Resolved—

(*a*) that in future the Sectional Committees during the meeting of the Congress shall select topics for discussion at the next Session of the Congress and make necessary arrangements: (i) through the President of the Section concerned for discussions within a Section, and (ii) through the Sectional President who has initiated the proposal for a discussion in which more than one Section will participate,

(*b*) that the Sectional Presidents concerned shall communicate to the General Secretary before the end of July the titles of such discussions, the names of the speakers and such further information as may be considered necessary,

(*c*) that the papers together with three copies of abstracts to be read by contributors shall be sent to the General Secretary on or before the 15th September of the preceding calendar year by the Sectional President concerned, (*d*) that the materials relating to a discussion in a form ready for the Press shall be communicated by the Sectional President concerned to the General Secretary within a month from the date on which the discussion takes place and that material not received by the General Secretary within this period shall not be published,

(*e*) that the President and the Recorder of the Section arranging a discussion shall carry out the necessary correspondence throughout the year during which they hold office.

Resolved further that consequential additions and alterations be made in the Rules, Regulations and instructions to Sectional Officers.

4. MEETINGS OF THE EXECUTIVE COMMITTEE.

Ten meetings of the Executive Committee were held during the year 1938-39. The following were among the important items of business transacted:

(1) A resolution passed by the Section of Zoology recommending to the Executive Committee for urging the Government of India the necessity of constituting an all-India Department of Fisheries for the development of the fishery resources of Indian waters on scientific lines was properly given action to.

(2) Diwan Anand Kumar, Local Secretary of the Twenty-sixth Session, was co-opted as member of the Executive Committee.

(3) The resolution for the separation of the Office of the Association from the Royal Asiatic Society of Bengal and for having a permanent office staff of its own was adopted.

(4) The recommendation for the separation of the Section of Mathematics and Physics into two independent Sections was made for consideration of the General Committee.

(5) The recommendation for creating a new Section of Entomology was made for consideration of the General Committee.

(6) The recommendation for the separation of the Section of Medical Research from the Section of Medical and Veterinary Research and for creating a new Section of Veterinary and Dairy Research was made for consideration of the General Committee.

(7) Prof. P. Parija was appointed General Secretary vice Mr. W. D. West resigned.

(8) The invitation of the Madras University to hold the Twenty-seventh Session (1940) of the Congress at Madras was accepted.

(9) A number of additions to and alterations in the Rules and Regulations were recommended for consideration of the Council and the General Committee, the details of which have been given in sections dealing with the Meetings of the General Committee and the Council.

(10) The appointment of Prof. B. Sahni as President of the Association for the year 1940 was confirmed.

(11) The view expressed in a joint meeting of the Sections of Entomology and Zoology during the Silver Jubilee Session of the Indian Science Congress in Calcutta in January, 1938, stressing that, in consideration of the scientific interest and practical importance, Entomology should be recognized by the Universities in India as an independent subject of study was referred to the Secretary, the Inter-University Board, for favour of necessary action.

(12) Sectional Presidents, Recorders, Sectional Correspondents and Local Sectional Secretaries for the next Session were nominated after consideration of the recommendations of the Sectional Committee. The names of Sectional Presidents and Recorders of the eleven Sections have been given in section dealing with the Meeting of the General Committee and the names of Sectional Correspondents and Local Sectional Secretaries for the Session 1939-40 are given below:

Section of Mathematics.

Sectional Correspondent .. Prof. J. Ghosh, Calcutta.
Local Sectional Secretary .. Dr. R. Vaidyanathaswamy, Madras.

Section of Physics.

Sectional Correspondent .. Dr. S. C. Sirkar, Calcutta.
Local Sectional Secretary .. Mr. R. N. Selvam, Madras.

Section of Chemistry.

Sectional Correspondent .. Mr. S. N. Mukherjee, Calcutta.
Local Sectional Secretary .. Dr. S. Rajagopal Naidu, Madras.

Section of Geology.

Sectional Correspondent .. Mr. N. N. Chatterjee, Calcutta.
Local Sectional Secretary .. Prof. C. K. K. Pillai, Madras.

Section of Geography and Geodesy.

Sectional Correspondent .. Mr. A. K. Banerjee, Calcutta.
Local Sectional Secretary .. Mr. B. M. Thirunaranan, Madras.

Section of Botany.

Sectional Correspondent .. Dr. J. C. Sen-Gupta, Calcutta.
Local Sectional Secretary .. Mr. R. V. Narayanaswami, Madras.

Section of Zoology.

Sectional Correspondent .. Mr. J. L. Bhaduri, Calcutta.
Local Sectional Secretary .. Prof. S. G. M. Ramanujam, Madras.

Section of Entomology.

Sectional Correspondent .. Dr. P. Sen, Calcutta.
Local Sectional Secretary .. Dr. J. P. Joshua, Madras.

Section of Anthropology.

Sectional Correspondent .. Mr. J. K. Bose, Calcutta.
Local Sectional Secretary .. Dr. A. Aiyappan, Madras.

Section of Medical and Veterinary Research.

Sectional Correspondent .. Rai Bahadur K. N. Bagchi, Calcutta.
Local Sectional Secretary .. Dr. S. Ramakrishnan, Madras.

Section of Agriculture.

Sectional Correspondent .. Dr. R. P. Mitra, Calcutta.
Local Sectional Secretary .. Mr. K. T. Alwa, Madras.

Section of Physiology.

Sectional Correspondent .. Dr. B. Mukerji, Calcutta.
Local Sectional Secretary .. Prof. B. T. Krishnan, Madras.

Section of Psychology.

Sectional Correspondent .. Mr. G. Pal, Calcutta.
Local Sectional Secretary .. Dr. T. M. P. Mahadevan, Madras.

(13) The Section of Mathematics being separated (*vide* Meeting of the General Committee) Prof. A. C. Banerji and Dr. M. R. Siddiqi were appointed the President and Recorder of the Section respectively after consideration of the recommendations of the Sectional Committee of the Section of Mathematics and Physics.

(14) The Section of Entomology being created (*vide* Meeting of the General Committee) Dr. H. S. Pruthi and Mr. D. D. Mukerji were appointed the President and Recorder of the Section respectively after consideration of the recommendations of the Sectional Committee of the Section of Zoology.

E. RESOLUTIONS ADOPTED BY SECTIONS.

Section of Mathematics and Physics.

The Committee recommended that if Mathematics and Physics are formed as two separate Sections then at least one day during the Session should be set apart for a joint meeting of the two Sections. The Presidents of the two Sections may decide by consultation and papers of mutual interest should be taken up at the joint meeting.

Section of Geology.

The members of the Geology Section passed a resolution deeply regretting the untimely death of Mr. M. P. Bajpai under the most tragic circumstances in November 1938 and expressed their deepest sympathy with the bereaved family.

Section of Botany.

It was resolved to form an Indian Committee of the International Society of Phytosociology and Geobotany and a committee consisting of the following members with power to co-opt was appointed. The committee will consider the question from all points of view and put definite proposals before the next Session of the Indian Science Congress:

Personnel of the Committee :

Dr. F. R. Bharucha (*Secretary*).
Prof. S. P. Agharkar.
Dr. N. L. Bor.

Section of Anthropology.

1. A resolution was carried to record its deep sense of sorrow on the death of the late Sàrat Chandra Mitra for many years a lecturer in the Department of Anthropology, Calcutta University.

2. With a view to educate public opinion and to get the people interested in Anthropological Research it was resolved to establish a committee consisting of the following members to draw up a plan in this direction which should be presented at the next Session:

Dr. D. N. Majumdar (*Convener*).
Dr. C. L. Fabri (*Secretary*).
Lt.-Col. D. H. Gordon.
Prof. K. P. Chattopadhyay.
Rai Bahadur Sarat Chandra Roy.
The President of the Anthropology Section of the 27th Session of the Indian Science Congress.

F RULES AND REGULATIONS, INDIAN SCIENCE CONGRESS ASSOCIATION.

RULES.

1. The name of the Association shall be the Indian Science Congress Association, and its object shall be the advancement of Science in India by the annual holding of a Congress and the doing of all such things as are incidental or conducive to the above object, including—

   (a) the holding and management of funds and property;
   (b) the acquisition of rights and privileges necessary or convenient for the object of the Association;
   (c) the management, development, improvement, disposal, and sale of all and any parts of the property of the Association.

2. The Association shall consist of Ordinary Members and Session Members.

3. Ordinary Members of the Association shall have the right to contribute papers for reading at the Session of the Congress, to receive free of charge all publications issued by the Association, and to fill any office in the Association on being duly elected thereto.

4. The annual subscription of Ordinary Members shall be Rs.10. The subscription shall become due on the 1st February of each year, and shall only be effective as a payment for Ordinary membership subscription if received before the 15th July of the year.

5. Any Ordinary Member may compound for the payment of all future annual subscriptions by the payment in a single sum of Rs.150.

6. There shall be three classes of Session Members :—

   (a) Full Session Members—subscription Rs.10 per Session.
   (b) Associate Session Members—subscription Rs.5 per Session.
   (c) Student Session Members—subscription Rs.2 per Session.

7. Full Session Members shall have the right to contribute papers for reading at the Session of the Congress, and to receive free of charge all publications issued by the Association relating to the Session of the Congress of which they are Members.

Associate and Student Session Members shall have the right to submit papers for reading at the Session of the Congress of which they are Members provided such papers be communicated through an Ordinary Member of the Association.

A Student Member shall before admission be duly certified by the head of his Institution to be a *bona fide* student.

8. The official year of the Association shall commence from the 1st of February.

9. There shall be Officers of the Association consisting of the Members of the Executive Committee and Presidents and Recorders of Sections.

10. Only Ordinary Members shall hold office in the Association.

11. The term of office of all Officers of the Association except the President shall commence from the beginning of the official year and shall extend until the assumption of office by their successors appointed in accordance with the provisions of these Rules. The President shall assume office on the opening day of the Annual Congress following the one at which he is appointed, and shall continue to hold office until the assumption of office by his successor.

12. There shall be an Executive Committee which shall carry on the administrative work of the Association and submit such questions

as it thinks desirable to a General Committee at its Annual Meeting during the Session of the Congress or at a Special Meeting of which due notice shall have been given.

13. The Executive Committee shall consist of the President, the President-elect for the following year, the three General Secretaries, the Treasurer and seven Ordinary Members elected by the General Committee. For the purpose of this election any Ordinary Member may propose the name of an Ordinary Member for election to the Executive Committee. Such proposal must be seconded by another Ordinary Member and must reach the General Secretary before the 15th September. The Executive Committee shall circulate these names, together with such other names, not exceeding three, as it may suggest, to all Ordinary Members for election by ballot. The ballot papers will be scrutinized by the President and the General Secretaries, and the results of the ballot will be announced at the meeting of the General Committee.

The Executive Committee shall co-opt as Members at least one and not more than two Local Secretaries for the ensuing Session of the Congress.

14. The Executive Committee shall have full power to transact all business in cases of emergency, notwithstanding any limitations hereinafter laid down, and to deal with all matters not otherwise provided for in these Rules, including the making of such Regulations as may appear conducive to the good administration of the Association and the attainment of its object; provided always that such Regulations be not inconsistent with anything contained in these Rules, that they be reported for the information of the next meeting of the General Committee, and that they be subject to rescission or alteration by the Executive Committee or by any meeting of the General Committee.

15. There shall be a General Committee which shall consist of all Ordinary Members of the Association.

16. The General Committee shall meet at least once during each Session of the Congress, preferably, in the middle of the Session.

17. There shall be a Council which shall consist of all Members of the Executive Committee, and all such Ordinary Members of the Association as have held office as President, General Secretary, Treasurer, or Managing Secretary of the Association, the Sectional Presidents for the ensuing Session, and in addition seven Ordinary Members of the Association elected by the General Committee. For the purpose of this election any Ordinary Member may propose the name of an Ordinary Member for election to the Council. Such proposal must be seconded by another Ordinary Member and must reach the General Secretary before the 15th September. The Executive Committee shall circulate these names, together with such other names, not exceeding three, as it may suggest, to all Ordinary Members for election by ballot. The ballot papers will be scrutinized by the President and the General Secretaries, and the results of the ballot will be announced at the meeting of the General Committee.

18. The function of the Council shall be to act as a body of advisers to be consulted by the Executive Committee on important questions of policy or scientific import.

19. There shall be a President who shall be nominated by the Executive Committee and whose nomination shall be submitted to the General Committee at its Annual Meeting during the Session of the Congress for confirmation.

20. There shall be three General Secretaries two of whom shall be resident in Calcutta and who shall be nominated by the Executive Committee and whose nomination shall be submitted to the General Committee at its Annual Meeting during the Session of the Congress for confirmation.

21. There shall be a Treasurer who shall be nominated by the Executive Committee and whose nomination shall be submitted for

confirmation to the General Committee at its Annual Meeting during the Session of the Congress.

22. The term of office of each General Secretary and of the Treasurer shall be for a period of five years following the confirmation of the appointment of any one of them, and each of them shall be eligible for re-appointment.

23. In the event of a vacancy amongst the General Secretaries and the Treasurer occurring between two Sessions of the Congress the Executive Committee shall have power to appoint a General Secretary or the Treasurer for the period up to the termination of the next Session of the Congress.

24. There shall be a Local Secretary or Local Secretaries for each Session of the Congress who shall be appointed by the Executive Committee.

25. There shall be a Local Committee for each Session of the Congress which shall be appointed by the Executive Committee.

26. The Local Secretary, or Secretaries, and the Local Committee shall jointly, on behalf of and in consultation with the Executive Committee, make all necessary arrangements for the holding of the Session of the Congress.

27. For the purpose of scientific deliberation during the Session of the Congress there shall be such Sections corresponding to different branches of science as may from time to time be constituted by the General Committee on the recommendation of the Executive Committee. It shall be competent for any section after the first day's meeting to hold its scientific meetings in sub-sections for the purpose of dealing separately with different groups of papers submitted to that Section. A separate chairman may be appointed by the Sectional President in consultation with the Sectional Committee to preside over each sub-section.

28. There shall be in each Section a President and a Recorder who shall be appointed by the Executive Committee. In addition there shall be a Sectional Correspondent and a Local Sectional Secretary who shall be appointed by the Executive Committee.

29. In each Section there shall be Sectional Officers, namely, a President, a Recorder, a Sectional Correspondent, and a Local Sectional Secretary. The President and the Recorder shall be the chief executive officers of the Section. They shall have power to act on behalf of the Sectional Committee in any matter of urgency which cannot be brought before the Sectional Committee for consideration, and they shall report such action to the Sectional Committee at its next meeting.

The work of each Section shall be conducted by a Sectional Committee which shall be constituted as follows :—

(a) Sectional Officers.
(b) All Ordinary Members of the Association who have been President or Recorder of the Section.
(c) Two Ordinary Members of the Association elected by the General Committee at its Annual Meeting during the Session of the Congress.

The Sectional President shall preside over all meetings of the Section and of the Sectional Committee. He shall be the convener of the meetings of the Sectional Committee. His ruling shall be final on all points of order that may arise.

The Sectional Recorder shall act as the Secretary of the Sectional Committee, and shall maintain a proper record of the proceedings of the Sectional Committee and of the Section in a book provided for the purpose. He shall be responsible for the punctual transmission to the General Secretary of the recommendations adopted by the Sectional Committee, and of resolutions adopted by the Section.

The Sectional Correspondent shall be resident at the headquarters of the Association, and shall be responsible for preparing for the press the material relating to his Section, according to the instructions of the Sectional President.

The Local Sectional Secretary shall be resident in the locality where the Annual Session is held, and shall be responsible for all local arrangements for the work of his Section, and for arranging the Sectional excursions in consultation with the Local Secretaries.

30. The Sectional Committee shall meet on the opening day of each Session of the Congress, and daily thereafter during the Session before the meeting of the Section unless otherwise determined at a meeting of the Sectional Committee.

In the absence of the Sectional President from any of its meetings the most senior member of the Sectional Committee present shall take the chair.

In their meeting on the opening day they shall :—

(*a*) nominate a Sectional President and a Sectional Recorder for the ensuing year for the consideration of the Executive Committee ;
(*b*) determine the detailed arrangements for the Sectional meetings ;
(*c*) select the papers to be read and discussed ;

and in their meetings during the Session they shall also :—

(*d*) nominate a Sectional Correspondent and a Local Sectional Secretary for the ensuing year for the consideration of the Executive Committee ;
(*e*) determine the contents of the Sectional record in the Proceedings in accordance with Rule 31 (*e*) ;
(*f*) consider means of improving the scientific work of the Section, and make suggestions to the Executive Committee whenever considered necessary.
(*g*) select topics for discussions at the next Session of the Congress and make necessary arrangements (i) through the President of the Section concerned for discussions within a Section and (ii) through the Sectional President who has initiated the proposal for a discussion in which more than one Section will participate.

31. (*a*) All papers submitted for reading at the next Session of the Congress shall be forwarded to the General Secretary so as to reach him not later than September 15th of the calendar year preceding the Session of the Congress at which the papers are intended to be read, provided that this date may be changed by the Executive Committee for special reasons.

(*b*) Any paper submitted for reading at the Session of the Congress shall be accompanied by an abstract in triplicate.

(*c*) All papers submitted for reading at a Session of the Congress shall be checked by the Sectional Correspondent concerned or by such person or persons appointed by the General Secretary. The papers together with a copy each of the abstracts shall then be sent to the Sectional President concerned for refereeing and acceptance. Decisions with regard to acceptance or rejection of any paper shall be final and all reports confidential.

(*d*) No paper published elsewhere shall be accepted.

(*e*) Only abstracts of the papers received by the General Secretary before September 15th in accordance with Rule 31 (*a*) (*b*) and (*c*) shall be printed in Part III of the Proceedings. In exceptional circumstances abstracts of papers received after that date and read before the Section, if specially recommended by the Sectional Committee, may be printed in Part IV.

32. The Proceedings of the Indian Science Congress Association shall be published in one volume in four separate parts, as follows :—

I. To contain the list of officers, the proceedings of the opening meeting (except the General Presidential Address) and all official matters.
II. To contain the Presidential Addresses. To be distributed to those present at the meeting after the addresses have been delivered, and to absent Ordinary and Full Session Members by post after the meeting.
III. To contain the abstracts of papers to be read before the Sections which are received before September 15th in accordance with Rule 31 (*a*). No abstracts shall be included in this volume from authors who have not already enrolled themselves as Members of the Association. To be distributed in advance of the Meeting to all Members of the Association.
IV. To contain the discussions, late abstracts accepted in accordance with Rule 31 (*e*), the list of members and the index.

33. The following procedure shall be observed for the making of any addition to or alteration in the Rules of the Association :—

(i) Proposals for additions to and alterations in the existing Rules may be placed at any time before the General Committee by the Executive Committee.
(ii) (*a*) Proposals for additions to and alterations in the existing Rules by any Ordinary Member of the Association shall be sent to one of the General Secretaries so as to reach him two full months before the meeting of the General Committee in which they are to be moved.
  (*b*) One of the General Secretaries shall circulate such proposals to all Ordinary Members of the Association at least one full month before the meeting of the General Committee.
  (*c*) Any amendments to the proposals shall be sent by any Ordinary Member of the Association to one of the General Secretaries so as to reach him at least a fortnight before the meeting of the General Committee.
  (*d*) The proposals together with any amendments shall be brought up before the meeting of the General Committee at its Annual Meeting during the Session of the Congress together with any remarks of the Executive Committee and declared carried if accepted by a two-thirds majority of the constituent Members present and voting at the meeting.

(Adopted the 5th January, 1931.
Revised the 5th January, 1935,
the 6th January, 1936, the
5th January, 1937 and the 8th
January, 1939.)

REGULATIONS.

I. SECTIONAL OFFICERS.

(1) The President delivers a Presidential Address of which ordinarily the cost of printing 25 pages of the Proceedings in its usual form shall be borne by the Indian Science Congress Association. The manuscript of the address, ready for the press, should be received by the General Secretary before October 15th of the calendar year preceding the Session

of the Congress at which the address will be delivered, provided that this date may be changed by the Executive Committee for special reasons. It should be accompanied by 12 copies of a short popular summary (about 500 words) for issue to the lay press. The time and date of the delivery of the President's address will be communicated before the meeting of the Congress. No two Presidential addresses will be delivered at the same time.

(2) The President shall be entitled to receive 30 copies of his address without charge, and additional copies at the cost of reproduction.

(3) Railway fares, postage, clerical, or other expenses incurred by the Sectional Presidents will not be paid by the Association.

(4) The following procedure is adopted for the collection of papers for the Sections :—

> About the middle of April a number of copies of a printed circular will be forwarded to the President of each Section who may arrange to send these to workers in that branch of science with which his Section is concerned, requesting them to contribute papers for reading before the next meeting of the Congress.
>
> The circular will contain a clause inviting such workers as are not yet Ordinary Members of the Association to join as such. Particular note should be taken of the fact that no new Ordinary Members are enrolled after the 15th July of the year.
>
> In the case of joint papers, each author must be a Member of some category.

(5) The President referees, either in person or by proxy, the papers received for reading before his Section in accordance with Rule 31.

Abstracts should be limited, except in very special cases, to about 200 words. Long abstracts should be reduced by the President. References to literature in abstracts should be avoided as far as possible and when given should conform to the system of abbreviations used by the Association.

The contents of all abstracts should be carefully checked by the Sectional Correspondent concerned or by such person or persons appointed by the General Secretary, and the abstracts shall then be sent to the Sectional President for his final scrutiny and approval.

Joint discussions on related papers may be held. Authors of papers should be informed of the time allotted by the President to the reading of their papers. An author contributing more than one paper should be asked to specify which of them he would prefer to read at the meeting.

(6) The President, in consultation with the Local Sectional Secretary, shall make arrangements for such local Sectional excursions as seem desirable. Due notice shall be given to the General Secretaries of all such arrangements.

(7) The President and Recorder should, in consultation with other members of the Sectional Committee, make proposals to the General Secretary regarding the programme of the Section. Such proposals should reach the General Secretary not later than the 1st November, so as to enable the necessary details to be entered in the programme. General discussions on questions of importance, held either by a single Section or jointly by two or more Sections, should be encouraged.

The Sectional Presidents concerned shall communicate to the General Secretary before the end of July the titles of such discussions, the names of the speakers and such further information as may be considered necessary.

The Papers, together with three copies of abstracts, to be read by the contributors at a discussion shall be sent to the General Secretary on or before the 15th September of the preceding calendar year by the Sectional President concerned.

The materials relating to a discussion, in a form ready for the press, shall be communicated to the General Secretary within a month from the date on which the discussion takes place; the material not received by the General Secretary within this period shall not be published.

The President and the Recorder of the Section arranging a discussion shall carry out the necessary correspondence throughout the year during which they hold office.

(8) Early in November copies of a printed form will be issued to Presidents of Sections for circulation to members of the Sectional Committees requesting them to nominate a President and a Recorder for the ensuing meeting for consideration by the Sectional Committee. Such proposals shall be accompanied by a statement of qualifications of the nominees for the office and their willingness to accept the same if elected thereto.

During the first week of December, the President of each Section shall circulate all such proposals received by him, together with the statements of qualifications, to the members of the Sectional Committee and request them to nominate by ballot one member for each office from among the list circulated, the ballot papers being received by him up to the 20th December.

At the first meeting of the Sectional Committee held on the Opening Day, the ballot papers shall be opened and scrutinized as the Chairman shall direct and the result communicated to the Executive Committee for consideration, together with a complete record of the Proceedings in this connection.

(9) The duties of the Sectional Correspondent and of the Local Sectional Secretary are given in Rule 29 and 31(*c*).

(10) All persons entitled to be members of the Sectional Committee should enrol themselves without delay as Ordinary Members if not already so enrolled and should inform the General Secretary of the payment of their subscription when accepting the appointment.

(11) The General Secretary should be consulted whenever any question arises not dealt with in these regulations.

II. LOCAL ARRANGEMENTS.

In accordance with the Rules of the Association, the Local Secretaries and the Local Committee shall jointly, on behalf of and in consultation with the Executive Committee, make all necessary arrangements for the holding of the Session of the Congress.

The following arrangements have to be made.

A. Accommodation for the Scientific Meetings.

(1) A large hall should be available for (*a*) the President's address on the opening day, and (*b*) for the evening lectures. Both (*a*) and (*b*) are open to the public free of charge. A projection lantern with an operator should be available in this room, and it is a great advantage if loud speakers can be installed.

(2) Rooms for the meetings of the different Sections of the Congress should be provided and suitably furnished. An epidiascope with an operator should be provided in each sectional room. All the rooms should as far as possible be in close proximity. The following are the sections of the Congress :—

> Mathematics, Physics, Chemistry, Geology, Geography and Geodesy, Botany, Zoology, Entomology, Anthropology, Agriculture, Medical and Veterinary Research, Physiology, and Psychology.

(3) A Reception room should be provided in which Members can get information, write letters, etc. The Local Secretaries' Office should be as near as possible to this room. An arrangement should be made with the Postmaster-General to have a temporary Post Office in this room

and for all letters addressed to members c/o The Indian Science Congress to be delivered here. The Indian Science Congress Post Office should be situated as near as possible to the Reception room.

(4) A room near the Reception room should be set apart for the General Secretaries' Office, which will be opened therein from the 31st December.

(5) Provision should be made for lunch in European and Indian styles at moderate charges near the Reception room.

B. Accommodation for Visiting Members.

The Local Secretaries should send out, not later than the end of November, a printed circular to all Members enrolled, asking them if they desire that accommodation should be arranged for them. It is desirable, as far as possible, to provide private hospitality for the President, Sectional Presidents, and Officers of the Congress. In this circular information should be given regarding the types of accommodation available, with the charges, and the nature of the climate during the Session. The Local Secretaries will receive periodically from the General Secretary lists of Members enrolled at headquarters.

C. Programme of the Meeting.

(1) The Sections of the Congress meet daily in the morning generally from 9-30 A.M. Symposia or joint discussions will be held either in the morning, or from 2 P.M.

(2) Public lectures are arranged by the Executive Committee, and are given at 6 P.M. or 6-30 P.M.

(3) A printed guide with a map of the locality in which the Congress is held should be prepared for distribution to Members on the opening day. Only Ordinary and Full Session Members are entitled to the Guide Book free of cost. A small charge not exceeding Re.1 (to be fixed by the Local Committee) may be made to other Members desiring to have a copy. The Guide Book should contain a summary of information concerning the scientific and educational activities and a short history of the locality, in addition to general information likely to be of use to visitors.

(4) Arrangements should be made for giving due publicity to the activities of the Congress, both before and during the meeting.

(5) A list of Members with their local addresses where known should be printed and distributed on the opening day. A supplementary list should be typed and posted in the Reception room and maintained up to date. The Local Secretaries shall arrange for this.

(6) A provisional programme of social engagements should be drawn up by the Local Secretaries and sent to the General Secretary by the 25th November. It is essential that this be sent in time, as it has to be printed and distributed with the abstracts by the first week in December.

The General Secretary will make arrangements for printing the programme drafted as above and distributing these to Members enrolled at the time of the distribution of the abstracts.

The final programme shall be printed locally by the Local Committee in time for the opening of the Session.

D. General.

(1) Numbered badges for Members of the Congress will be sent by the General Secretary to the Local Secretaries for distribution on the opening day of the meeting. The badges should bear numbers corresponding to the enrolment numbers. There should be additional badges for Officers.

(2) Members of the Local Reception Committee who have made substantial contributions to the funds of the Local Committee may be given complimentary tickets to attend the meetings.

(3) An audited copy of the accounts of the Local Committee should be sent to the General Secretary not later than the 30th April, following the Session, for inclusion in the Proceedings of the Session. It is desirable that the Local Committee should contribute any surplus to the reserve fund of the Association.

(4) Twelve copies each of all local publications connected with the Congress (guide book, final programme, notices, cards, etc.) should be sent to the office of the Association for record at the conclusion of the meeting.

(5) Applications for membership will ordinarily be dealt with by the General Secretary at the office of the Association up to the 15th December. After that date applications for membership will be forwarded to the Local Secretaries, who will open a separate account for the sale of membership tickets. The amount thus realised, together with unsold tickets, should be forwarded to the General Secretary immediately after the close of the Congress.

III. FINANCIAL.

(1) The accounts of the Association shall be audited once a year and the books closed on the 30th November each year for this purpose.

(2) The audited accounts shall be placed before the General Committee at the Annual Meeting with the observations, if any, of the Executive Comittee.

(3) Sanction for all payments for amounts exceeding Rs.100 shall be obtained from the Finance Committee which shall consist of the General Secretaries, the Treasurer, and one Ordinary Member resident in Calcutta who shall be nominated by the Executive Committee.

(Adopted the 5th January, 1937.
Revised the 8th January, 1939.)

G. STATEMENT OF ACCOUNTS.

I

The Indian Science Congress Association.

Receipts and Payments Accounts for the year ended 30th November, 1938.

Receipts.

	Rs.	A.	P.
To Balance on 1st December, 1937 ..	29,171	9	11
,, Reserve Fund	5,000	0	0
,, Members' Subscriptions	14,611	0	0
,, Contributions for the Celebration of the Silver Jubilee	11,812	0	0
,, Contributions for Excursion	367	2	0
,, Unspent balance from Local Reception Committee	338	1	0
,, Sale of Publications	1,837	10	0
,, Miscellaneous Receipts	370	10	6
,, Interest on Investments	399	0	0
Total ..	63,907	1	5

Payments.

	Rs.	A.	P.	Rs.	A.	P.
By Printing Charges	..			17,853	9	0
,, Postage	..			3,125	2	6
,, Contingencies	..			1,309	12	3
,, Salaries	..			1,077	10	0
,, Stationery	..			133	1	0
,, Audit Fee	..			50	0	0
,, Travelling	..			471	4	6
,, Tour Expenses	..			4,702	6	0
,, Contributions—						
Royal Asiatic Society of Bengal	600	0	0			
Current Science ..	250	0	0			
Indian Science News Association	250	0	0			
				1,100	0	0
,, Passages	..			1,330	11	6
,, Honorarium	..			7,175	1	3
,, Metal Badges	..			1,489	0	0
,, Balance on 30th November, 1938—						
Investments—4% Loan 1960/70 for Rs.10,000 at cost	..			11,416	10	0
With Imperial Bank of India on Current Account	..			12,672	13	5
Total ..				63,907	1	5

Examined with the Books and Vouchers and found in accordance therewith.

Price, Waterhouse, Peat & Co.

Calcutta,
21st December, 1938.

Auditors.
Chartered Accountants,
Registered Accountants.

P. Brown,
Honorary Treasurer.

Proceedings of the Twenty-sixth Indian Science Congress

PART II—PRESIDENTIAL ADDRESSES

CONTENTS

PAGE

Presidential Address : By Congress President .. 1

1. Section of Mathematics and Physics 19
2. ,, ,, Chemistry 45
3. ,, ,, Geology 65
4. ,, ,, Geography and Geodesy 99
5. ,, ,, Botany 141
6. ,, ,, Zoology 169
7. ,, ,, Anthropology 179
8. ,, ,, Medical and Veterinary Research .. 225
9. ,, ,, Agriculture 271
10. ,, ,, Physiology 317
11. ,, ,, Psychology 341

Presidential Address

Congress President:—PROF. J. C. GHOSH, D.Sc., F.N.I.

The Indian Science Congress meets today at Lahore for the third time. Those of us who attended the meeting of the Congress held in 1927 know well that in warmth of welcome and hospitality, and in providing a congenial atmosphere for our deliberations, this city has few equals; and I am sure that on this occasion also, she will live up to that reputation. As President that year, we had Sir Jagadish Chandra Bose, and I well remember the illuminating address in which he outlined some of his beautiful methods for probing the secrets of plant life. That voice is now stilled in death, but he will always be remembered with gratitude as the great Master and Pioneer whose work and example have revived the spirit of scientific enquiry in India after centuries of stagnation.

Last year, the Indian Science Congress celebrated its jubilee with great pomp in the city of Calcutta, which had witnessed the birth of this Association two years after her dethronement from the proud position of the Imperial Capital. A brilliant galaxy of scientists took part in the deliberations, and for President we had elected the greatest scientist of the British Empire. The sudden death of Lord Rutherford was a cruel blow, but it was some consolation that he finished the writing of his inspiring address which was read by his brilliant successor Sir James Jeans.

As I recall today these great names, I feel weighed down by a sense of responsibility. To follow them is perforce to follow very far behind. Eleven years ago, Professor Simonsen was called to this office, and in the course of his address, he suggested that the chemists of India should study more intensively the wealth of natural materials that lay at their doors, and devote less time to the study of problems of only theoretical interest. In the decade that has passed since Professor Simonsen made this eloquent appeal, the organic chemists of India have made many important contributions to our knowledge in this field. Only recently I attended the symposium on this subject held at Bombay under the auspices of the National Institute of Sciences. Distinguished visitors from Lahore, Bangalore and Calcutta joined in the discussion and it looked like a miniature science congress. While not long ago, Professor Simonsen was the solo-scientist in this field, we have now flourishing centres of research at Lahore under the guidance of Dr. J. N. Ray and at Bangalore under Dr. P. C. Guha. Valuable work is being done in Bengal, by Dr. P. C. Mitter, Dr. P. K. Bose, Dr. Khuda and Dr. Guha Sarkar, in Bombay, by Drs. Wheeler, Shaha, Venkataraman and their colleagues, in Madras, by Dr. B. B. Dey, at Allahabad, by Dr. S. Dutta and at Aligarh, by Dr. Siddique. Although their interests are mainly pharmacological, Colonel Chopra and Professor S. Ghosh have carried out systematic chemical examinations of many indigenous medicinal plants at the School of Tropical Medicine. In very broad outlines, it may be stated that these investigations have embraced the isolation, the determination of the constitution, and in some cases the synthesis, of a large variety of terpenes, bitter principles, glucosides, plant colouring matters, alkaloids, etc. Special mention may be made in this connection of P. C. Mitter's elegant synthesis of *Munjisthin*, J. N. Ray's work on berberine, palmitine and vasicine, and P. C. Guha's synthetic work on thujane, pinane and camphane series.

To a physical chemist, the development of a new technique for the separation of allied substances occurring together in nature has a special appeal. In the Bombay symposium, Prof. Ray demonstrated the existence of six allied colouring matters in rottlerin by their differential adsorption on specially prepared surfaces of alumina. Equipments for fractional distillation under very high vacuum, 10^{-5} or 10^{-6} cm. of mercury, are now not rare. In the laboratories of Drs. Krishnan, B. B. Ray, K. Banerjee and Mata Prasad, have been installed excellent X'ray equipments for determining the configurations of unit cells in organic crystals. It is hoped that these methods will find increasing applications in the Indian laboratories where many difficult problems are now being tackled by chemists who estimate work by its quality and not by any other standard.

The subjects of vitamins and hormones have now become favourite topics of conversation even in our drawing rooms; and in recent years Nobel Prizes have become practically the monopoly of the great leaders in this field—Hopkins, Neuberg, Wieland, Szent-Gyorgi, Haworth and Peters. It is a matter of satisfaction that synthetic work in India is being directed more and more to the preparation of substances of biological importance. The elegant syntheses by Bardhan and co-workers in the phenanthrene, hydrophenanthrene and retene groups which are closely allied to the sex-hormones have justly received a wide recognition. A class of compounds which now fills the centre of the picture in the chemical world is known as the sterols. Irradiated ergosterol is the vitamin D which is responsible for the formation of bones in animal organisms. It is remarkable that in the economy of nature these sterols should be so closely related on one side to the cancer-producing substances and on the other to the sex-hormones. Vegetable oils and plant juices contain any number of sterols, and I commend to your attention the work on plant sterols that is being done by Drs. K. P. Basu and Nath in Dacca.

Dr. B. C. Guha and co-workers have isolated renoflavin from ox-kidney, and have thrown considerable light on the multiple nature of vitamin B_2 of which lacto-flavin is one component. It may interest you to know that pure and crystalline lacto-flavin is now available in the market at a cost of Rs.1,000 per gram, and physico-chemical methods have been evolved for estimating it even to a billionth of a gram. Since Szent-Gyorgi's classical investigation on the isolation of vitamin C in a pure crystalline form, the determination of its constitution has formed the subject of brilliant work by Haworth and his school. Work of considerable value has been done in India on the occurrence, stability and physical properties of this vitamin. In the pure state, it is easily oxidized by the oxygen of the air, but it is remarkable that it is very stable in plant and animal organisms, though the tissues receive an ample supply of oxygen. This stability has been traced to the simultaneous presence in these tissues of sulphur compounds or of chlorophyll which act as powerful inhibitors of this auto-oxidation (Ghosh and Rakshit).

In the limited time at my disposal, it is not possible to refer to all the investigations in this field, but I have given you sufficient indication of the striking change that has come over in the outlook of our organic chemists. Professor Simonsen's appeal from this chair has fallen on a rich soil and is now bearing ample fruit.

A few years ago, Sir Gilbert Morgan referred to the question that was often anxiously raised in the British chemical circles as to 'what had become of inorganic chemistry' and gave a decidedly assuring reply by his masterly survey of the progress of modern inorganic chemistry. He showed how apart from such sensational discoveries as the hydrogen isotope or Deuterium, inorganic chemistry has now gained freshness of outlook and fertile fields of research by new ideas on valence force. Three kinds of links are now well-recognized as binding atoms to form molecules, or binding molecules to form, what we used to call, additive compounds. They are: (1) the electrovalent link where the forces are mostly of electrical attraction, (2) the covalent links where the atoms are bound together by sharing two electrons, and (3) the co-ordinate links where generally both the shared electrons come from the same atom. The applications of these theories have been amazingly wide. To mention only a few, I may refer to ionic isomerism, isomorphism in crystalline compounds, stability of organometallic compounds, especially when one associating compound occupies two places in the co-ordination complex and the elucidation of the structure of even such a complex molecule as $H_3P(W_3O_{10})_4 . n . H_2O$, where the chemist's intuition has been verified by X'ray analysis.

A similar question 'What has become of inorganic chemistry in India?' has often been asked and by no less an eminent person than Sir P. C. Ray. The dawn of modern chemical researches in India was heralded by his discovery of mercurous nitrite which was followed by many interesting studies on the stability and the properties of the nitrites. The University College of Science at Calcutta has continued to be a very active centre of research in this field. Indeed Sir Gilbert Morgan's review contains appreciative references to the researches of Dr. P. B. Sarkar, which revealed the isomorphism of the thiocyanates and acetylacetones of scandium with those of the iron family, and to his interesting study on the homology of berylliofluorides, sulphates, and monofluophosphate ions. This work has been followed by the interesting discovery that a nitrite can form mixed crystals with such an apparently dissimilar ion as the formate. Of the many interesting contributions of Professor P. R. Ray, I may mention his preparation of the two isomeric modifications of thiosulphuric acid, whose salts are commonly known as hypo in commerce.

One of the most remarkable developments in the field of inorganic chemistry has been the discovery of specific reagents for detecting and estimating metallic radicals even when present in such small traces as one millionth of a gram. These newer methods of micro-chemical analysis bid fair to supersede, in ordinary laboratory practice, the painstaking and disagreeable methods of qualitative and quantitative separation which have hitherto formed the basis of a chemist's practical training.

To the Indian chemists we owe the introduction of many important microchemical reagents, *e.g.* rubeanic acid, urotropine, quinaldinic acid, dimercaptothiobiazole, and the triple nitrites of the alkali and rare earth metals. These names may appear as Greek to many votaries of other sciences who are present here, but I may assure them, that if these reagents were in common use in their early youth, the goddess of chemistry would not have appeared to them in her frowning forbidding looks, and perhaps many of them would not have hesitated to transfer even their allegiance to her.

But when all is said and done, it cannot be denied that the enthusiasm for research in organic chemistry has overshadowed the claims of inorganic chemistry in India. Isolated work in this field appears often from the laboratories of Lahore, Patna, Bombay and Bangalore, but they do not appear to emanate from flourishing centres of research, where the wisdom and experience of elders combine with the freshness, enthusiasm and devotion of the younger men and create new channels of knowledge. This lop-sided development is indeed to be deplored. They say that all knowledge is one; and with greater truth can it be said now, that there are no longer any barriers between organic and inorganic chemistry. With our newer ideas of valency, the systematization of the enormous accumulation of chemical facts is no longer the prerogative of organic chemistry. Nor can it be said now that the nature of carbon-carbon links is better understood, in spite of its regularity of behaviour, than the links between the other atoms. The elucidation of the structure of inorganic compounds has to be tackled more or less on the same principles which are familiar to the organic chemists. In the common region of the two sciences a vast body of organometallic compounds has emerged, which apart from their interest in micro-chemical process of analysis, are now working miracles in the fields of industry and in the alleviation of human suffering. I need only mention a few names—lead tetraethyl, neosalvarsan, neostibosan. Our president of the Indore Session described last year how Kala Azar had been practically eliminated from the otherwise smiling fields of Assam and Eastern Bengal, with the aid of the drug ureastibamine. Antimony III pyrocatechine disulphonate of sodium has brought under control Bilharziasis in Egypt, and is now named Fouaden after the King of Egypt, who took a great interest in this work. With inorganic chemistry revitalized by the electron concepts of valence, there is a rich harvest to be garnered in the near future by our brilliant young chemists, if only they could resist the lure of pure organic chemistry.

A sketch in bold lines of the progress of physical chemistry in India may not be out of place here, if only to complete the picture that was drawn by Professor Bhatnagar as the President of the Chemistry Section of our congress in 1928. It was only after the war that this branch of chemistry came really to be cultivated in the Indian laboratories. Progress here depends no doubt, as in other branches of knowledge on inspiring leadership; but the proper equipment of laboratories is also an equally vital factor for success. In many centres, this youthful science has suffered from a chronic anæmia for lack of funds available for research; and the cry has sometimes been raised in authoritative circles, that in consideration of this lack of resources, physical chemistry should better be merged into physics. It is also extremely unfortunate that the professorship of physical chemistry in the Indian Institute of Science at Bangalore should have been kept in abeyance, and the department practically wiped off the scene. Now that the Irvine Committee has strongly deprecated this measure of retrenchment, it is to be hoped that the department of physical chemistry should re-occupy, at an early date a worthy place in that Institute, which was intended to be the premier centre for chemical researches in India.

The credit of initiating researches in physical chemistry in India goes to Professor Dhar who was called to the chair of chemistry at Allahabad in 1919. Then came in 1921, the three musketeers from the laboratory of Professor F. G. Donnan—Bhatnagar, Mukherjee and Ghosh; and later on the torch has been kept burning by Qureshi at Osmania, Joshi at Benares, Mata Prasad at Bombay, Ganguli and Ray at Patna, Krishnamurty and Kappanna at Nagpur, Ramkrishna Rao and Gopal Rao at Waltair, and Sanjib Rao and Jatkar at Bangalore.

During recent years Dhar and his pupils have applied the methods of physical chemistry to the elucidation of various chemical processes that occur in soils and have come to the conclusion that tropical sunlight is one of the governing factors in these transformations. Such powerful radiations easily decompose potassium nitrate, bring about reaction between sulphurous acid and oxygen, give rise to formaldehyde in solutions of alkaline bicarbonate, and in presence of catalytic surfaces like zinc oxide, and titanium oxide, even produce amino acids by reaction of glucose with potassium nitrate. They have observed that amino-acids are readily oxidized to ammonia in air and light, and ammonium salts in their turn are oxidized to nitrites and nitrates. These observations coupled with the fact that the amount of nitrate in the soils of Northern India is maximum in summer when bacterial activity is practically negligible, lead to the very important conclusion that tropical light plays an important rôle in the nitrification of soils. The parallel investigations of Fowler, Subramanyan and their collaborators on the fixation of nitrogen in energy-rich soil with the aid of micro-organisms, of Dr. P. K. De on the fixation of nitrogen by pure algæ and of Dhar on the fixation of nitrogen by catalytic surfaces during the photo-oxidation of organic residues are throwing a flood of light on the economy of carbon and nitrogen in the soil system. This is, as it should be, for the fundamental problem of Indian agriculture is the conservation of nitrogen and moisture in the soil. It is a matter for sincere congratulation that these researches on soil processes will be continued with greater chances of success, because of the singleness of purpose and devotion, in the Indian Institute of Soil Science which has been recently established at Allahabad by Professor Dhar.

While Professor Dhar's interest has centred round the physico-chemical processes that occur in soils, Professor Mukherjee has of late concentrated his attention on the colloid chemical behaviour of the soil constituents. He has applied with success his well-known theory of the electrical adsorption of ions to the elucidation of the properties of clay-acids and soil-suspensions. The accurate experimental technique which he has evolved, in this connection, for the determination of cataphoretic speed, and for conductometric and electrometric titration of acid-sols is well worthy of imitation in all soil science and electro-chemical laboratories. The colloid constituents of the soil are responsible for many of its most important physical properties, its power of holding water, of forming crumbs and tilth and for its general relation to plant growth. Professor Mukherjee has gone into the root of the problem. He has made comparative studies of the changes that happen when alkali is gradually added to (1) simple sparingly soluble acids in: (*a*) presence, or (*b*) absence of solid phase, (2) to colloidal acids like palmitic and silicic acids and finally, (3) to the far more complex clay acids. His programme of work may well serve as a model when a complex piece of very difficult research is planned; results of far reaching value have thus been obtained which have received wide recognition in Europe. It is also worthy of note that researches on the colloidal behaviour of drilling mud has just been started by the Assam Oil Company under the supervision of Professor Mukherjee at Calcutta. The problem of reversible transformations of suspensions into jelly-like masses and *vice versa* is also of great technical interest. The studies of Professor Mata Prasad on the mechanism of the formation of many inorganic and organic gels thus deserve special mention. By the proper control of H^+ion concentration, he has prepared many beautiful transparent gels whose properties are being exhaustively studied by him. An important application of the methods of colloid chemical separation to a problem of great therapeutic interest has been made by Dr. B. N. Ghosh who is investigating the physico-chemical properties of snake venom. The possibility of separating completely the neurotoxin from the hæmolysin factor in the snake venom appears to be at a promising stage of development.

Apart from his ever-increasing activities as a pioneer industrial chemist, to which reference will be made later, Professor Bhatnagar has carried on systematic investigations on magnetochemistry and molecular structure. Perhaps the most sensitive instrument that has yet been designed for the study of magnetic susceptibility is the Bhatnagar-Mathur interferometer balance, which has now been put in the market by Adam Hilger, Ltd. I wish it were possible to discuss in detail and in a non-technical manner, the more important contributions of Bhatnagar, D. M. Bose, P. R. Ray and Krishnan to the rapidly developing field of magneto-chemistry. It is well known that in a non-uniform field, paramagnetic substances experience a tractive force towards the strongest part of the field, while diamagnetic substances experience a similar force to the weakest part. Bhatnagar has shown that such magnetic behaviour is not an unchanging property of atoms or ions. The remarkable fact has been noted that paramagnetic substances like iron, nickel and cobalt, exhibit diamagnetism when adsorbed by charcoal, which indicates that chemical valence forces are in operation in the process of adsorption. The magnetic susceptibilities of organic isomeric molecules are not the same, but depend on the arrangement of the atoms in the molecule. Again the study of chemical reaction in a magnetic field has led to the important generalization, that the velocity of reaction is accelerated, retarded or unaffected by the field according as the sum of the molecular susceptibilities of the final products is greater, less or equal to the sum of the molecular susceptibilities of the initial substances.

Important researches are in progress at Benares on the mechanism of chemical reactions under electric discharge. It has been found that many chemical reactions will occur only if the voltage across the reaction space exceeds a limiting value which has been aptly termed the threshold potential. Traces of impurities which act as catalytic poisons also increase considerably this threshold potential. Velocities of reaction were also found to be markedly depressed in presence of molecules which have large affinities for electrons.

While the laboratories at Lahore and Benares are engaged in the study of properties of molecules in magnetic and electric fields, physico-chemical researches in Dacca have been concerned with an intensive study of the interplay of matter and radiation, mostly in liquid systems. The nature of such interaction when atoms and molecules are in the gaseous state, is now fairly well understood, but in liquids the phenomenon is much more complicated. Our interest ceases when the light absorbed is simply converted into heat. But radiant energy, of a particular wave-length, may in some cases be absorbed by a molecule, which immediately emits a band of secondary radiation. This is the so-called fluorescent band. For a true understanding of the mechanism of the process it is necessary to measure accurately the distribution of energy over the various wave-lengths of such a band and also to compare the amount of radiant energy absorbed by a molecule with the amount that it emits as fluorescence. This ratio is called the fluorescent yield. Absolute photometric methods of extreme sensitiveness have been devised, and some of the results obtained may here be stated. As the concentration of fluorescent molecules in an inert solvent like water or alcohol diminishes, the fluorescent yield increases until a maximum steady value is reached at molecular concentrations of the order of 10^{-4} or 10^{-5}. Electro-chemical studies indicate that at these low concentrations, the fluorescent molecules only exist as simple ions whereas at higher concentrations ionic aggregates or micelles are formed. The decrease in fluorescent efficiency is associated with an increase in the complexity of ions. Even under the most favourable conditions, this efficiency never reaches unity. Molecules like rhodamine and fluorescien are good energy transformers, the yield reaching up to ·8, while low down in the list we have phosphine G with an yield of ·1 of the absorbed energy. A molecule of rhodamine again may absorb a quantum of radiation corresponding to wave lengths 313, 365, 436, 546, 10^{-7} cm. But in each case, the nature of the fluorescent band and the amount of fluorescent energy per quantum of absorbed radiation remain the same, though the absolute magnitude of the exciting quanta thus varies over a wide range. It is possible to go deeper into the problem. For example, in the delicate experiments of Mr. S. Mitra, a beam of light with vibrations arranged in one plane only, was made to strike such a molecular target in a viscous medium, and the fluorescent light measured along a direction normal to the plane containing the direction of vibration and the direction of propagation of incident light. It was found that in the fluorescent light the vibration along the direction of propagation is generally less intense than the vibration in the perpendicular direction. This anisotropy, or polarization as it is called, diminishes as the viscosity of the medium diminishes. This is to be expected for if within the life period of the excited molecule, which is of the order of 10^{-10} second, the fluorescent molecule is capable of considerable free rotation in all possible directions, no particular direction of vibration will be favoured in the emitted light. Based on this elegant method, the life period of excited molecules has been measured.

The emission of fluorescent light is a relatively simple response called forth in a molecule under the stimulus of radiation. A more complex process occurs when the radiation is stored up as the internal energy of molecules. The green plants bottle up sunshine to the extent of 670,000 calories when they transform six gram molecules of carbon dioxide and water into one mol of sugar. These are the fundamental capitalists of the world on whom all the animals have to depend for their existence. A molecule with such an accumulated store of energy may occasionally remain fairly stable as in the case of sugars. But in other cases instability and far-reaching changes are noticed; for example, with bromine the molecule splits up into two atoms: in the case of iodine, either the molecule is split up or an excited molecule is formed. These free atoms and excited molecules are very active agents and they start all kinds of reactions when other receptive molecules are present. Where the induced chemical reaction is attended with evolution of heat, each such atom or molecule acts, as it were, as a centre of explosion, which proceeds in a chain involving sometimes the transformation of hundreds of molecules. The conditions which are favourable for the propagation of such chains, the dependence of the chain length on the magnitude of the quantum of radiation responsible for starting the chain, the disruption of the chain by substances which we call catalytic poisons, the life period of excited atoms and molecules, and of the unstable substances that are formed as intermediate products in such reactions,—these are some of the problems which have been studied in Dacca.

It is possible with the aid of suitable devices to obtain a beam of light in which the vibrations are circular and either dextro-rotatory, *i.e.* moving in the direction of the hand of the clock, or lævo-rotatory, *i.e.* moving in a contrary sense. Such radiations may be called in short dextro-light or lævo-light. If dextro-light has a different velocity than lævo-light in a medium, the medium is said to be optically active. Again if the absorption coefficient of dextro-light is different from that of lævo-light, the medium is said to be circularly dichroic. Such optical activity and circular dichroism are often exhibited by naturally occurring molecules; and the prevalence of such asymmetry in living organism has been considered as a proof in favour of vitalism. The brilliant researches of Kuhn in 1930 indicated how with the aid of one kind of circular light, an asymmetric molecule can be decomposed in preference to its optical isomer which is always present in equal amount in all synthetically produced substances. The plant pigments which under the stimulus of solar radiation are responsible for the production of complex organic materials, exist in living cells as colloidal micelles, which are both optically active and circularly dichroic. Attempts to prepare relatively simple colloidal micelles exhibiting circular diochroism have been quite successful in our laboratories. When colloidal solutions of tungstic acid, vanadic acid, or ceric borate are allowed to mature in dextro-light which they are capable of absorbing, the molecules during the process of aggregation to form micelles appear to be subjected to the directive influence of such radiations. Such colloidal solutions have greater absorption for dextro-light than for lævo-light, *i.e.* they become circularly dichroic. Experiments now in progress also lead to the conclusion, that these dichroic suspensions, which become active oxidizing agents under the influence of light, exhibit differences in the velocities of oxidation, when exposed to equal intensities of oppositely polarized circular vibrations. It looks now, as if it may be possible to prepare in the laboratory, simple anisotropic catalysts which will produce much faster one optically active substance in preference to its isomer.

I should not let this occasion pass without dwelling on a matter of vital importance relating to the training of a physical chemist. Half a century ago, this science was brought into being by the labours of Van't Hoff, Arrhenius, Ostwald, and Raoult. Even the mathematical equipment of Van't Hoff, the greatest of these leaders, was according to Sir James Walker, no better than that of an ordinary graduate in mathematics. An easy familiarity with relatively simple mathematical tools coupled with a clear grasp of the fundamental laws of physics, has since enabled many to collect a rich harvest from the virgin soil. But things are now changing fast. The appointment of Dr. Lenard Jones to the chair of inorganic and physical chemistry in Cambridge is a symbolic event. Of a physical chemist is now demanded not only a sound basic training in chemistry, supplemented by a high experimental skill in handling delicate instruments but also a clear understanding of the higher branches of applied mathematics and statistics. How we wish that we were trained up on this basis; but let not those who come after us, have occasion to complain that they did not receive proper guidance and counsel in the years of their apprenticeship. And I appeal to the Indian Universities to take up seriously the question of a thorough overhauling of the methods of teaching this branch of knowledge.

I must confess that the section of physics and mathematics has to its credit more far-reaching discoveries than the section of chemistry. I need only mention the Raman effect, the Shaha theory of thermal ionization in stellar systems and the Bose Statistics. I should like to stress here one great obstacle to progress, which the chemists of India have not yet been able to remove. Chemists are apt to describe themselves as the most painstaking of all animals—not even the ass excepted. It is more true of their science than that of any other, that innumerable experiments must be performed, innumerable facts observed, catalogued, correlated and classified before an important generalization can be made or the structure of a new conception of the phenomenal world can be raised. But life is short and science is long. Hence it is, that we find that outstanding discoveries in chemistry have in recent years been made in laboratories, where inspiring leadership has been associated with large-scale team work. The paper on the synthesis and constitution of vitamin C appeared from the Birmingham laboratories under the joint authorship of a team of seven workers. Such team-work is, however, yet comparatively unknown in India. It is to be deplored that the idea of close co-operation among the scientific workers, has not taken a firm root in the Indian soil. Is it due to the fact, that the traditional religious atmosphere of India teaches a child to be self-centred, to be complete within himself and to work out his own salvation, unaided and in isolation? Then again, I am told, that a tradition has grown in some institutions, that the senior member of the staff is given credit for senior authorship in a joint publication, independent of any consideration of the share he may have in the planning and execution of the work. This, if true, is unfortunate, for the highest spirit of co-operation, loyalty and devotion can only be evoked in an atmosphere of impartial justice and deepest sympathy and good will. Notwithstanding these handicaps, there are pointers to the road of success. In the palmy days when Sir C. V. Raman was Professor in Calcutta, one could easily feel that in his laboratory, the researcher has become forgetful of self and mindful only of the work ahead. One also notes with pleasure the observation of Sir John Russel that Professor Mukherjee is fortunate in having secured the help of a band of skilled and devoted workers in his researches on soil colloids. Any casual reader of Indian publications in chemistry will not fail to see that work of considerable value has been done during the last decade. He will observe, however, that it is the individual enterprise in research, rather than a magnificent team work to solve a fundamental problem, which has been up till now, the keynote of our activities. But for greater efforts and higher achievements we should all endeavour to inaugurate an era of co-operative team work.

Within the precincts of this university, it is not necessary that I should have to make a special pleading for the theses that scientific knowledge and industrial activities should be co-ordinated or that our academic laboratories should not be divorced from practical affairs. We have here a flourishing Honours School of technical chemistry; and the genius of Professor Bhatnagar has provided a bridge of communication between scientists and industrialists. Nowhere is the beneficial effects of contact between universities and industry better exemplified than in the programme of researches on oil technology, now carried out under the supervision of Professor Bhatnagar, with the aid of funds provided by Messrs. Steel Brothers. In pre-war days, such close intimacy existed in Germany alone, with the result that she rapidly outstripped her rivals in industrial enterprise. But a new epoch of industrial research in Europe and America has begun with the end of the great war. Last year in the Presidential address of Lord Rutherford we had a very clear exposition of the extensive activities of the Department of Scientific and Industrial Research in Great Britain. He stated with evident satisfaction that this bold experiment in the co-operative organization of research, which is unique in the world, had undoubtedly proved a great success.

The Government of India have, in recent years, done a good deal in promoting researches relating to plant industries. The Royal Commission on Agriculture has ardently looked forward to a state of affairs in which the universities will not only initiate agricultural research but will also undertake schemes of research, the importance of which is brought to their notice by the departments of agriculture. This end has been steadily kept in view by the Imperial Council of Agricultural Research. We have already referred to the researches of Professor Dhar and Mukherjee. With the aid of funds provided by this council, long-range schemes of research are in progress in the statistical laboratory of Professor Mahalanobis at Calcutta, in the chemical laboratories at Dacca, and in the botanical laboratories of Agra, Madras and Benares. The cotton technological laboratory at Bombay, the Institute of cotton breeding at Indore, the Imperial Institute of sugar technology at Cawnpore, the cane breeding station at Coimbatore, the jute technological laboratory at Calcutta and the agricultural research laboratory for jute at Dacca are notable examples of the solicitude of the Central Government for meeting the research requirements of valuable money crops. Researches on forest products have been organized in the Forest Research Institute at Dehra Dun and the Lac Research Institute at Ranchi. The work that is being done in these institutions has gone far to refute the allegation that Indian chemists are doing little to help industry. Take for instance, the lac industry. Researches are in progress under Dr. H. K. Sen, relating: (*a*) to better methods of washing stick-lac to produce high grade seed-lac, (*b*) separation of pure lac resin from ordinary shellac, (*c*) bleaching of lac, (*d*) recovery of refuse lac, and (*e*) production of moulded articles for electrical industry and household use. With synthetic resins, like bakelite, having entered the field, it is certain that severe competition is ahead. But now that science has been linked to this industry, we may hope with greater confidence, that the lac industry of Chotanagpur will not meet with the same fate as the indigo cultivation of Behar.

At Dehra Dun the 'Ascu' process of Mr. Kamesam which fixes arsenic and copper in wood through the agency of chromium salts has given rise to a wood preservation industry. The researches of Dr. S. Krishna on 'Ephedra' have helped Baluchistan in organizing the trade in this drug. Of particular interest is the work that is now being done there on vegetable tallows. The physical and chemical properties of mowra tallow and sal butter have been studied, and they are recommended as admirably suited for yarn sizing. It is estimated that about 400,000 maunds of these tallows can be put in the market; and owing to their cheaper cost of production, they are expected to displace animal tallows for various industrial purposes. Nor should we forget to mention that researches conducted on proper utilization of such forest products as bamboo and grass, have resulted in the establishment of several paper factories; and the time is not far off when the country will be producing enough pulp from these raw materials to meet the overgrowing demand for paper. Dr. Chaudhury and co-workers at Dacca have made extensive studies on the properties of the jute fibre. They have found that colour can be improved considerably by the action of chlorine peroxide, the tensile strength and resistance against rot by the action of formaldehyde, that jute nitrocellulose can be made as stable as cotton nitrocellulose, and that owing to its lower viscosity and high solubility, it would be more useful for the lacquer industry. It has been found that the jute plant does not ret in tanks of galvanized iron; and Dr. Barkar, in his recent review of jute industry in India, has drawn pointed attention to this observation, as indicating the possibility of controlled retting in central stations for the production of high grade fibres.

I have dwelt in some detail on these researches on money crops which have received generous assistance from public funds, in accordance with the recommendation of the Agricultural Commission, with a view to bringing out in bolder relief the cold indifference with which the recommendations of the Indian Industrial Commission have been received by the Central Government. Much was expected of the policy laid down by the Government of India in 1915, under the stress of the war, that India would consider herself entitled to demand the utmost help which her Government could afford to enable her to take her proper place in the world as a manufacturing country. But these lessons of war were soon forgotten, and all that has been achieved is the setting up of an Industrial Research Bureau, controlling with the aid of an Advisory Committee, a small research laboratory attached to the Test House at Alipur. The report of this Bureau for 1937-38 is a miserable document compared with the corresponding report of the Imperial Council of Agricultural Research. I should not be misunderstood. I have no complaint against the personnel, but only against the stepmotherly treatment meted out to industrial research in the country. Nor should we forget that many great leaders of public opinion have been so impressed by the evils of the modern capitalistic world that they have not hesitated to declare that the introduction into India of the scientific and technical methods of the west should be resisted; that it is no business of governments to subsidize higher scientific research; those who employ scientific men or exploit their researches should pay for their training and provide them with facilities for work. The forces of public opinion and of Government rarely join hands in this country, but men of science found to their dismay, that this miracle was going to happen in this instance. It was feared that human society in India would in the end crystallize into a community of artisans and peasants. It is therefore with great relief and thanksgiving that we welcome the resolution passed at the conference of the provincial Ministers of Industries recently held at Delhi that the problems of poverty and unemployment, of national defence and economic regeneration in general, cannot be solved without industrialization; and as a step to such industrialization, a national planning committee should be set up which will formulate comprehensive schemes for the development of industries in India.

As an indispensable adjunct to this planning commission there should be set up an All-India Council of Scientific and Industrial Research with functions and powers similar to those entrusted to the Department of Scientific and Industrial Research in Great Britain. In India, however, men and things get, so easily and without questioning, under official control that it would be apt to quote here the following observations of Lord Rutherford:—'In Great Britain the responsibility for planning the programme of research even when the cost is directly borne by the Government rests with research councils and committees who are not themselves state servants, but distinguished representatives of pure science and industry. It is to be hoped that if any comparable organization were set up in India, there will be a proper representation of scientific men from the universities and also of the industries concerned.'

Indeed for any one who has followed the recent happenings in this world, with any attention, this industrial planning for India would seem to be long overdue. Now, more than ever, a planning on all fronts, would seem an urgent and immediate necessity. The lesson of the crumbling empires, and the rapid rise of countries organized in deadly earnest are patent to all but the oblivious utopian. If an industrial and progressive India appeared a desirable necessity in 1915, how much more urgent and imperative would such a task of consolidation of her intellectual and material resources appear to all in 1938. But we orientals often forget realities, in our search for the ideal; with the furious tempo of development and consolidation all round, the least delay, however, in this urgent task may prove fatal and irreparable in the end. Already we are regrettably late in putting forth our best efforts in this direction,—but now that events have rudely awakened us to the dangers that our slackness exposes us to, we should try to make up for lost time by forced marches in the path of progress, and by a resolute determination to pool all our material and intellectual resources to solve our own problems. It is obvious that such a tremendous task cannot be achieved by isolated efforts of industrialists, and by private enterprise. The utmost co-operation of the individual with the state will be necessary if real success is to be achieved.

The stupendous task need not make us despair. The very creditable performances of her sons in the different spheres of scientific and intellectual activity have amply demonstrated that with proper guidance and plan, India is quite capable of solving her own problems, and of maintaining her position and ideal with dignity and prestige. What is only wanted is prudence and foresight, liberal statesmanship, resolute co-operation and efficient leadership.

The universities of India have a great responsibility to discharge at this juncture. If the process of industrialization is going to be a forced march in this country it will not do for them to take up an attitude of *laissez-faire*. The forces of nature are the enduring wealth of mankind, but for the solution of India's economic problems and the prosperity of her 380 millions, it is necessary that brilliant young men should be trained up in ever-increasing numbers, who are capable of tapping these sources of wealth. The modern young student of science must realize that while fundamental theoretical work must continue to be basis of all scientific advance, his subject would lose much of its importance, if this training did not fit him for tackling large-scale problems which arise in industries. Simultaneously with the development of industries, there arises in every country a great demand for well-trained personnel to man these industries. Professor Philips recently estimated that 12,000 graduates in chemistry are employed in industrial pursuits in England. Lord Rutherford even complained that the demand in England for well-trained researchers in physics had outrun the supply. Dr. Hamor, assistant Director of the Mellon Institute for Industrial Research, has estimated that in 1937, America spent about 100 million dollars in scientific and industrial research; and though the expenditure is high, the results have more than fulfilled expectations, even if for a time, some of them may be kept secret. Such a consummation may be long in coming to India, but every effort should be made to prepare the ground in advance. A very good example of what the Indian universities can do in this direction has been shown by Bombay, where under the inspiring leadership of Mr. Chandravarkar and the able guidance of Dr. Forster, an Institute of Textile Chemistry and Chemical Engineering has been established, which in equipment has few equals. Already successful students have so proved their worth, that, I am told, there is an advance booking from the millowners for the products of this institution.

It is a welcome sign of the times that the Indian industrialists are not all blind to the value of research as a means of improving production, and in consequence, of increasing the demand. The Tata Iron and Steel Works have led the way by the foundation of a magnificent laboratory at Jamshedpur for the study of alloys of iron and steel. The Lala Sriram Trust contemplates establishing soon at Delhi an Institute on the model of the Mellon Institute of America. The Luxminarayan Bequest at Nagpur may soon begin to yield the beneficial results which the donor so ardently cherished. But when one recalls that most of the industries in India are now sheltered by a tariff wall—call it revenue tariff or protective tariff as you like,—and that a substantial part of the income of the Indian business magnates accrues to them because of this tariff, one has a right to expect a much wider recognition on their part of the need for co-operation between science and industry, and a greater readiness to endow industrial research with a view to cheapening production. Such research is considered, in all enlightened countries, as an insurance against the dark days; and today when the world seems so much out of joint, the enlightened industrialists should do well to consider themselves only as servants of society—essentially moral beings whose main dividends are the benefits, which they confer by providing employment, and by manufacturing commodities essential for the national well-being.

But the world will not be set right if this change in outlook were confined to one class of men only. Every intelligent man and woman have now got to ponder deeply over the problem that the scientific search for truth has not assured the advance of civilization. Inventions intended to relieve toil, and to control the forces of nature which should have given to all a fuller and more satisfying life, have been preverted into forging instruments of destruction. The paradox of poverty amidst plenty mocks us in the face. In one part of the world wheat and cotton are being burnt and milk thrown into streams, while in another part half-naked people are starving. It is not difficult to get at the root of this evil. In respect of scientific knowledge and its applications to the problems of life, each generation stands on the shoulders of the preceding one, but in respect of social, cultural and spiritual qualities, no comparable development is noticeable—perhaps there has been a retrogression since the days of Asoka and Christ. Modern science has, indeed, become a menace to civilization, because we have refused to work for social justice, because the interests of individuals and communities have not been subordinated to those of the country, and because considerations of patriotism and the prejudices of race, creed, and colour, have been allowed to override the wider considerations of humanity. Therein lies the tragedy of the modern world—the tragedy that we witness in the flaming cities of Spain and China, in the mountain homes of Abyssinia, and in the concentrated hatred in the armed camps of Europe.

'It is not enough that mankind should be provided with tools of progress. It is a much bigger task to teach them how to use these tools. Men of science cannot escape moral responsibility even for the evil fruits of their labours.' The chaos of modern world is calling out to every man of good will and understanding to join in a great educative effort, with a view to making the minds of men more flexible and adaptable, with a view to removing those narrow prejudices which are choking the paths of progress. These prejudices did not matter much in olden days, when communications were difficult—in fact, they were born because of such inaccessibility. But today when increasing rapidity of communications is causing the world to shrink with a disconcerting rapidity, these prejudices spell disaster for mankind. We, on this occasion, therefore welcome the efforts of the British Association and the American Association for the Advancement of Science to mobilize the moral forces of the world for promoting better relations between men and nations, and we offer them our willing co-operation.

In this hall, many years ago, the first President of the Indian Science Congress, Sir Asutosh Mookerjee concluded an inspiring address with the hymn:

'Where knowledge is free
Where words come out from the depths of truth,
Where the clear stream of reason has not lost its way into
the dreary desert sand of dead habit.
Unto that Heaven of Freedom, my Father, let my country
awake'

Search for such a Heaven of Truth and Freedom—self-surrender to such a great quest—it is to this, that the noblest spirits are called; and it is such men and women who make the world a better place to live in. May we all join in this quest.

SECTION OF MATHEMATICS AND PHYSICS

President :—K. R. Ramanathan, M.A., D.Sc., F.N.I.

Presidential Address

THE EARTH'S MAGNETISM AND THE UPPER ATMOSPHERE.

Introduction.

I have chosen as the subject of my address, 'The Earth's Magnetism and the Upper Atmosphere'. In the seventh session of the Indian Science Congress which was held at Nagpur in 1920, Dr. N. A. F. Moos presided over the section of Mathematics and Physics and spoke on 'Seismology and Earth's Magnetism'. Dr. Moos was the head of the Colaba and Alibag observatories for twenty-five years and his two volumes on 'Colaba Magnetic Data and their Discussion' contain many scholarly studies of an original character and still remain a vast storehouse of information for magnetic data. Dr. Moos is no more with us, but his work lives and inspires.

In recent years, considerable progress has been made in our knowledge of the upper atmosphere—from sounding balloons, investigation of the heights of appearance and disappearance of meteors, reflection of sound waves, atmospheric ozone, light from the night sky and auroræ, regular and irregular variations of the earth's magnetic field and, most fruitful of all, the experimental study of the ionosphere. It was, however, the study of the earth's magnetism that made the first definite contribution to our knowledge regarding the electrical properties of the earth's atmosphere. It still provides a healthy check on theories regarding the upper atmosphere and continues to be suggestive of fresh problems for experimental and theoretical investigation. On the other hand, knowledge derived from other sources is helping to unravel some of the complicated phenomena of the earth's magnetism. My task will be to make a survey of some of the problems, mainly of the earth's atmosphere which a study of its magnetic field has opened up or illuminated.

The Earth's permanent magnetic field and its harmonic analysis.

Exactly a century has elapsed since the foundations of a scientific study of the origin of the earth's magnetism were laid by C. F. Gauss in his famous 'Allgemeine Theorie des Erdmagnetismus'.[1] Let us recall what he had to say about the aims which have to be kept in view in the study of the earth's magnetism:

> 'Viewed from the higher grounds of science, even a complete knowledge of the phenomena after this manner (representation of the geomagnetic field by accurate and detailed maps) is not itself the final object sought. It is rather analogous to what the astronomer has accomplished, when for example, he has observed the apparent path of a comet in the heavens. Until the complicated phenomena have been brought in subjection to a common principle, we have only building-stones, not an edifice. The astronomer, after the comet has disappeared from his view, begins his chief employment, and resting on the laws of gravitation, calculates from the observations the elements of its true path, and is thus enabled to predict its future course. And in like manner, the magnetician proposes to himself as the object of his research, as far as the different and in some respects less favourable circumstances permit, the study of the fundamental causes which produce the phenomena, their magnitude and their mode of operation—and the anticipation with some approximation at least, of their effects in those regions where observation has not yet penetrated. It is at least well to keep in mind this higher object, and to endeavour to prepare the way for it, even though the great imperfection of the data may render its attainment impossible at present.'

Gauss in his great memoir applied the theory of potential to the earth's magnetic field and developed the method of spherical harmonic analysis to analyze the permanent field of the earth.

What we observe experimentally is the distribution of the intensity of the magnetic field on the surface of the earth and changes in its distribution with time. From these results of observation, the origin of earth's magnetism and its changes has to be deduced. Gauss worked out a method by which definite information can be obtained regarding the location of the sources. This depends on the analysis of the auxiliary quantity —namely, the potential—from which the several components of the intensity of the earth's field can be derived, not only at the surface of the earth, but also at different positions above and below the surface. The distribution of potential on the surface of the earth can be determined from observations of horizontal force alone. A knowledge of the vertical force is not necessary for this. Gauss showed how the potential can be expanded in a double series of spherical harmonics. One of these series is due to causes within the earth and the other to causes outside. The potential due to internal sources has terms proportional to

a^2/r^2, a^3/r^3, a^4/r^4, etc. while that due to external ones has terms proportional to r/a, r^2/a^2, r^3/a^3, etc. By making use of the additional knowledge of the distribution of the vertical force, it is possible to separate the internal from the external parts of the potential.

Assuming that the magnetic matter was situated within the body of the earth, and using the data of magnetic field at a few places, Gauss calculated the distribution of permanent field over the surface of the earth and obtained a fair agreement between the calculated and observed distributions. Discussing the assumptions, Gauss remarks: 'Another part of our theory on which there may exist a doubt is the supposition that the agents of the terrestrial magnetic force are situated exclusively in the interior of the earth. If we seek for their immediate causes, partly or wholly, without the earth, and confine ourselves to known scientific grounds, we can only think of galvanic currents. But the atmosphere is no conductor of such currents, neither is vacant space; thus in seeking in the upper regions for a vehicle of galvanic currents we go beyond our knowledge. But our ignorance gives us no right absolutely to deny the possibility of such currents; we are forbidden to do so by the enigmatical phenomenon of the Aurora Borealis, in which there is every appearance that electricity in motion performs a principal part. It will therefore still be interesting to examine what form magnetic action arising from such currents would assume on the surface of the earth.' While showing that the cause of the permanent field of the earth should be definitely located within the earth, Gauss did not overlook the possibility 'of a part, though comparatively very small part, of the terrestrial magnetic force, proceeding from the upper regions'.

He also pointed out that the variations of magnetic force taking place simultaneously at different places on the earth's surface can be subjected to a perfectly similar treatment.

Before we pass on to a consideration of the changing part of the earth's field, it is useful to summarize some of the salient features of the 'permanent' or quasi-permanent magnetic field of the earth as they are known at present. This consists of a homogeneous or 'regular' part and an 'irregular' part, the former being due to terms of the first order in the series development for the potential. The regular field is the same as that due to a uniformly magnetized sphere of the same size as the earth, the intensity of magnetization being ·074 (about 1/5500 of the remanent magnetism of cobalt steel) and the total magnetic moment $8{\cdot}4 \times 10^{25}$ C.G.S. units. The axis of magnetization cuts the earth's surface at 78½°N., 69°W. and 78½°S., 249°W. and is thus inclined 11½° to the earth's axis of rotation. The analysis of the irregular or 'residual' part of the field shows that the average equivalent intensity of magnetization is greater for those latitudes in which land predominates.

The earth's total field is made up of a part due to an internal potential system which accounts for 94 per cent. and an external and a non-potential system which accounts for the remainder.

From the analysis of the earth's field carried out at different epochs from 1842 to 1922, it is known that the magnetic moment of the earth has decreased from $0{\cdot}328/a^3$ in 1842 to $0{\cdot}324/a^3$ in 1885 and $0{\cdot}311/a^3$ in 1922, the average *annual* rate of decrease in the intensity of magnetization during 80 years being $\frac{1}{1500}$ of its value. Therefore, in addition to the well-known secular change in the direction of the earth's magnetic axis, a slow demagnetization of the earth is also going on. Whether this will continue or reverse its direction after some time is more than we can say at present. Regarding secular variation, Maxwell says: 'What cause, whether exterior to the earth or in its inner depths, produces such enormous changes in the earth's magnetism, that its magnetic poles move slowly from one part of the globe to another? When we consider that the intensity of the magnetization of the great globe of the earth is quite comparable with that which we produce with much difficulty in our steel magnets, these immense changes in so large a body force us to conclude that we are not yet acquainted with one of the most powerful agents in nature, the scene of whose activity lies in those inner depths of the earth, to the knowledge of which we have so few means of access.' Although seismology has given us new insight into the internal structure of the earth and the study of magnetic daily variations and variations associated with magnetic storms has definitely added to our knowledge of the conductivity of the earth's interior, the position as regards the fundamental problem of the origin of the earth's permanent magnetic field has not appreciably advanced since Maxwell wrote.

Besides the slow secular variation there are many other variations, some regular and others irregular, to which the earth's magnetic field is subject. The principal regular variations are the solar and lunar diurnal variations and their changes with season and solar activity, the annual variation and the eleven-year variation. The irregular variations or disturbances are of many classes, the most conspicuous of them being the world-wide 'magnetic storms'. The disturbances also have quasi-periodicities depending on (1) the rotation of the sun, (2) the inclination of the earth's magnetic axis to its axis of rotation, and (3) the sunspot cycle. The study of the geomagnetic *variations* and of associated phenomena such as the auroræ has given valuable knowledge about the electrical properties of the earth's atmosphere.

The Solar diurnal variations of the earth's magnetic field and their analysis.

The solar diurnal variation is the most obvious and the most important of the periodic variations of the earth's magnetic field. At places on the same latitude, the variation depends mainly on the local time (owing to the non-coincidence of the magnetic and rotational axes of the earth and local variations of the earth's magnetic field, there are, however, small differences in the diurnal variation from place to place in the same latitude). On magnetically quiet days, the daily variation is much greater when the sun is above the horizon than when it is below; it is greater in summer than in winter and increases with increase of sunspot frequency. The variation shows large changes as we go from the equator to the pole.

How the sun causes the daily variations in the magnetism of the earth was discussed by Balfour Stewart[2] in a famous article in the ninth edition of the Encyclopædia Britannica. He surmised that the upper regions of the atmosphere were most probably the seat of solar influence with electric currents circulating in them and did not consider as serious what was then considered as an objection, viz., that the conductivity of ordinary air was too small to sustain currents. He also pointed out that a system of currents in the upper atmosphere would exert an indirect effect on the magnetic needle by inducing currents in the body of the earth.

Schuster[3] was the first to investigate the subject in a quantitative manner. The first step in his analysis of variation data was to split up the curve of variation of each of the components into Fourier series. Gauss's method of spherical harmonic analysis was then applied to the Fourier coefficients of

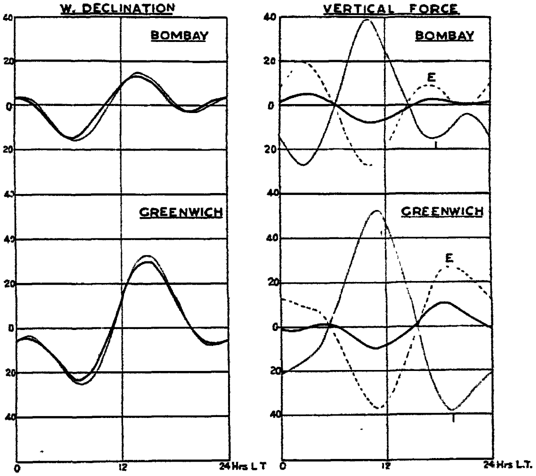


FIG. 1. Observed daily variation of declination and vertical force at Bombay and Greenwich (———) compared with values calculated on the assumption that the origin of the daily variations is (1) inside the earth (———) and (2) external to the earth (..........).

variation at four observatories—Bombay, Lisbon, Greenwich and St. Petersburg. He showed that the horizontal variation field could be represented by a surface harmonic but in order to explain the vertical variations as well, it was necessary to assume that the main source of disturbance lay outside the earth and that in addition to the external source, there was an internal source standing in fixed relationship to the external. In Fig. 1 are shown the observed variations of H at Bombay and Greenwich together with the variations calculated from the spherical harmonic expansion for the potential. On the right-hand side of the same figure are shown the observed variations of Z and the variations calculated from the potential distribution assuming that the source was (1) entirely outside the earth's surface and (2) entirely within the earth's surface. It is obvious that the main source has to be considered as lying outside the earth's surface.

A more complete analysis of the solar diurnal variation field using the data of 21 observatories was carried out by Chapman.[4] The results of the analysis are best expressed in the form of a diagram showing the system of electric currents in the upper atmosphere that could cause the observed field.

At the time of the equinoxes, the current system consists of four closed circuits, two lying on each side of the equator. Of the two circuits in each hemisphere, the one lying in the sunlit part of the earth is the more intense and the direction of the current is clockwise in the northern hemisphere with its focus at about 40°N. At the time of the solstices, the current system is more intense in the summer hemisphere and extends across the equator to the other hemisphere.

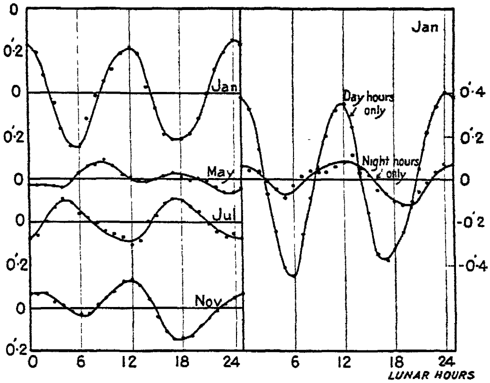
As the diurnal variation at the time of the equinoxes is symmetrical about the equator and as the vertical component of the variation field changes sign on crossing the equator, Schuster suggested that the electric currents are caused by horizontal oscillatory movements of the conducting upper atmosphere, rendered conducting by the ionizing action of solar ultra-violet radiation, across the vertical lines of force of the earth's field. The magnitude of the electromotive forces generated by such movements would depend on the velocity of movement and the vertical intensity. The current densities will of course depend also on the conductivity of the atmospheric layer which undergoes the oscillatory movement. The total flow of current in the day time circuit varies from 6×10^4 amperes at the time of the equinoxes to 9×10^4 in summer.

The Lunar diurnal variation field.

Before we go into the details of the oscillatory movement in the upper atmosphere, we shall consider an even simpler, though less obvious, variation field, namely that of lunar diurnal variation. Its mean magnitude at the equator is only about $\frac{1}{15}$ of that of the solar variation. When averaged over a large number of complete lunations, the curve of variation is a simple semi-diurnal sine wave. But in any particular phase of the moon, the amplitude is considerably enhanced during the daylight hours of the day. This was recognized as early as 1874 by Mr. Alan Broun [5] in his discussion of the observations of magnetic

FIG. 2.

MEAN LUNAR DIURNAL VARIATION OF DECLINATION AT TRIVANDRUM FROM A. BROUN'S ANALYSIS



declination at Trivandrum (Fig. 2). It is very well brought out in Moos's analysis of the lunar diurnal variation at Bombay in different phases of the moon. The external current systems required to produce the lunar diurnal variation at the times of equinoctial and summer new moons have been shown in diagrams by Chapman.

There is little doubt that the lunar semi-diurnal wave is due to the tidal action of the moon on an atmosphere of varying conductivity.

In both solar and lunar diurnal variation fields, the external part is 2 to 2·5 times the internal and the phase of each of the first four harmonic components of the internal field is in advance of the corresponding components of the external field by about 20°. This is the evidence for believing that the internal field is an induction effect of the external primary field. The electromotive forces induced in a conducting sphere by currents circulating in an outer shell have been investigated by H. Lamb. In order to explain the relative phases and amplitudes of the external and internal fields, it is necessary to assume that the conductivity of the earth is non-uniform and that the crust of the earth down to a depth of about 240 km. has much smaller conductivity than the inside. We shall not, however, pursue this part of the subject further.

Cause of the upper atmospheric current system and its location in the atmosphere.

In explaining the upper atmospheric current system, there are two distinct questions to be answered. What is the cause of the atmospheric movement and how is the conductivity produced ?

The answer to these questions has been attempted in the most comprehensive way in the 'dynomo' theory of diurnal variations. Schuster tried to connect the atmospheric movement with the well-known diurnal variation of atmospheric pressure. The most important term in the daily oscillation of pressure is the semi-diurnal term. This is a wandering pressure-wave moving from east to west with a free period of 12 hrs. together with a stationary wave from north to south with nodal lines at ±35° latitude. The magnitude of the semi-diurnal wave, according to Simpson, is given by the equation

$$0{\cdot}937 \sin^3\theta \sin(2t+154^\circ)+0{\cdot}137 (\cos^2\theta-\tfrac{1}{3}) \sin(2t-2\phi+105^\circ)$$

where θ is the co-latitude, ϕ is the longitude east of Greenwich, and the unit of pressure is 1 mm. of mercury. The relation between wind and pressure variation, in which the deviating force of the earth's rotation is neglected, is

$$(\tfrac{1}{2}v^2)\,(d\psi/dt) = -\delta p/p,$$

where ψ is the velocity-potential, $d\psi/ds$ the velocity in the direction ds and v is the velocity of sound. The velocity-field corresponding to the moving pressure-wave shows maximum easterly winds at 9-10 hrs. and maximum westerly winds at 15-16 hrs. local time. The calculated and observed values of the semi-diurnal components of velocity at St. Helena are given below:

Semi-diurnal winds at St. Helena.

	Observed.	*Calculated from pressure variation.*
West to East ..	$-22 \sin(2nt+158^\circ)$	$-21 \sin(2nt+154^\circ)$
North to South ..	$35 \sin(2nt+237^\circ)$	$9 \sin(2nt+244^\circ)$

The unit of velocity is 1 cm./sec. While the phases of the wind and the amplitudes of the west to east component agree, the observed north to south component is much stronger than the calculated.

The amplitude of the lunar semi-diurnal pressure tide at the equator is only about $\frac{1}{16}$ of the solar tide.

If the oscillations in the upper atmosphere causing the magnetic variations are directly related to the barometric variations observed at ground level, there should be agreement as regards phase between the two variations. Let us now compare them:

Cause of variation.	Observed pressure variation at ground level	Observed magnetic variation.	Pressure variation calculated from magnetic variation.	Col. (4) corrected for phase change due to self-induction.
Solar ..	sin $(2t-206°)$	sin $(2t-65°)$	sin $(2t-155°)$	sin $(2t-115°)$
Lunar ..	sin $(2t-295°)$	sin $(2t-12°)$	sin $(2t-102°)$	sin $(2t-62°)$

There is thus a difference of phase between the observed pressure variation at the ground and the upper atmospheric pressure variation calculated from magnetic data. The calculated value exceeds the observed by 91° in the case of solar and by 233° in the case of lunar variation.

The probable solution of this difficulty as well as of a cognate difficulty regarding the conductivity of the upper atmosphere has been recently offered by C. L. Pekeris.[6] The question of the origin of the solar semi-diurnal wave of pressure itself has long been a puzzle. Analysis of the pressure curves of many stations leaves no doubt that the semi-diurnal wave is more fundamental than the diurnal. We know that there is an external periodic force acting on the atmosphere in the shape of daily insolation. But it is not the 24-hourly pressure-wave that has the largest amplitude in the barograms but the 12-hourly. The magnitude of the 12-hourly wave can be explained, as was suggested by Lord Kelvin, if the atmosphere had a free period in the close neighbourhood of 12 hrs. From the spreading of the air-waves from the volcanic eruption at Krakatau, it has long been known that the atmosphere has a free period of about 10½ hrs. and G. I. Taylor showed theoretically that the atmosphere has a free mode of oscillation of this period. An assumption in Taylor's calculation of the free period was that the stratosphere was isothermal. Now, various lines of evidence, such as the propagation of sound waves from explosions, the existence of ozone in the upper atmosphere, etc. have shown that there is an increase of temperature in the stratosphere above 35 km. Pekeris, assuming that this increase of temperature continues up to about 60 km. (temperature 370°K), beyond which it again decreases, reaching 220°K at 100 km., shows that there are two possible modes of oscillation, one with a period 10½ hrs. and another with a period 12 hrs. The 12-hourly oscillation has a nodal surface at 30 km. and the atmospheres above and below this level oscillate horizontally in opposite directions. The amplitude of the 12-hourly wave at 100 km. is nearly 200 times that at the ground. The work of Pekeris removes to some extent the difficulties of the dynomo theory of the diurnal variation of the earth's magnetic field.

While on the subject of pressure waves in the upper atmosphere, I may refer to the recent announcement of E. V. Appleton and K. Weekes in *Nature* on the discovery of a lunar semi-diurnal wave in the height of the E layer over England. Making use of a series of quarter-hourly observations extending over a period of eight months, and suitably eliminating the effect of solar diurnal and seasonal variations of height, Appleton and Weekes have found evidence for the existence of a lunar semi-diurnal wave with a pressure range $\delta p/p$ of ·068 at 110 km., which comes to nearly 6,000 times the lunar barometric range at ground level. The maximum height of the lunar tide is found to occur at about 20 mts. before the upper and lower culminations of moon respectively. The magnitude of the oscillation is 1·5 to 2 km. A large discrepancy appears in that the phase of the upper atmospheric tide is found to be nearly the same as that at ground level at Greenwich, a conclusion which is in *disagreement* with deductions made from the lunar magnetic variations assuming such currents to flow in region E. The amplitude of the tide is also much larger than that calculated by Pekeris.

The conductivity of the upper atmospheric layers responsible for the solar diurnal variation.

The currents in the upper atmosphere depend on the conductivity at the levels concerned. The fact that the range of magnetic variation is much larger during day than during night both for solar and lunar variations can be most simply explained on the assumption that the conductivity is not constant but varies during the day. Assuming that the electric currents responsible for the diurnal variations lie in a spherical shell concentric with the earth, Chapman showed that the relative proportion of the various harmonics can be satisfactorily explained if the conductivity is assumed to be of the form $1+3\cos Z+\frac{9}{4}\cos^2 Z$, where Z is the zenith distance of the sun. If the velocities of oscillatory movement in the upper atmosphere are the same as those calculated from the surface barometric variation, the total conductivity $\int \sigma dh$ of the conducting layer just beneath the sun comes to $1{\cdot}1\times 10^{16}$ e.s. units in minimum sunspot years and $1{\cdot}8\times 10^{16}$ in maximum sunspot years. If the effect of self-induction is taken into account, the maximum conductivity will be increased to $2{\cdot}3\times 10^{16}$ e.s. units. If this conductivity is uniformly distributed over a thickness of 50 km., the mean specific conductivity will be $4{\cdot}5\times 10^{8}$ e.s. units or 5×10^{-3} ohm^{-1} cm^{-1}. This may be compared with the specific conductivity of sea-water which is 4×10^{-2} ohm^{-1} cm^{-2}.

The level of the solar diurnal variation layer.

The question of the level of the atmospheric layer in which the magnetic diurnal variations arise is one of great interest.

We know that maxima of electron concentration occur at about 100 km. in the E layer and at about 270 km. in the F layer. Besides, there is a D layer with a variable and smaller electron concentration at 50–60 km. A lower F_1 layer separates out from the main F_2 layer during day and rejoins it at night.

A comparison of the curves of variation of the ionization of different regions with the time of day, season and sunspot frequency suggests that the diurnal variation currents flow in or near the E region of the atmosphere.

The conductivity of any region of the upper atmosphere can be estimated from ionospheric data. In doing this, a few complicating circumstances have to be kept in mind. In a magnetic field, the conductivity of an ionized gas is not isotropic but is smaller in a direction transverse to the field than in one parallel to it, in the ratio $\nu^2/(\nu^2+\rho^2_H)$, where ν is the collision frequency of the charged particles and $\rho_H=He/2mc$. In high magnetic latitudes where the vertical component of the field is large, and also in low magnetic latitudes for east to west direction, it is the transverse conductivity that will decide the magnitude of the currents. Moreover, both electrons and ions can contribute to the conductivity. To make a correct estimate of the total conductivity of a region, we have therefore to know the law of distribution of ions and electrons with height. The question has been recently discussed in a thorough manner by Appleton[7] in his Bakerian Lecture 'Regularities and Irregularities in the Ionosphere'. He finds that the total direct current conductivity $\int \sigma dh$ of the E region for horizontal electromotive forces is about $2{\cdot}3\times10^{11}$ e.s. units if we assume that the conductivity is due to electrons, the maximum density of electrons being $1{\cdot}5\times10^{5}$/c.c. and their collision frequency at that level 10^{5}/sec. If on the other hand, it is assumed that the conductivity is due to ions of mass, say 28, and the corresponding collision frequency is 10^{3}, the total conductivity for the same number of ions comes out to be 4×10^{12} e.s. units. At a low pressure and in a magnetic field, the ionic conductivity can thus be more important than the electronic conductivity.

As an ionized region absorbs the energy of high frequency waves passing through it and the absorption is related to the conductivity, the total direct-current conductivity of the atmospheric layers below the F region can also be estimated from the reflection coefficients of waves penetrating the E layer but reflected back to earth from F. The total conductivity calculated in this manner for summer noon over England comes to be of the order 10^{11} e.s.u., assuming the absorption to be due to electrons.

As we have already seen, the D.C. conductivity demanded by magnetic diurnal variations is of the order 10^{16} e.s.u., if we assume that the oscillatory movements in the upper air are the same as those calculated from the barometric variations at ground-level. With Pekeris' correction the conductivity required will become 200 times smaller. Even then, it would be larger than that calculated from ionospheric data. This difficulty has been to a large extent removed by Massey's[8] recent work on atomic processes in the upper atmosphere in which he has shown that the rate of recombination of electrons in the E layer is much slower than that of either attachment or detachment and that an equilibrium ratio of 100 : 1 will be set up in that region in a few minutes between the negative ions and electrons. With a density of ions of 10^7/c.c. at 100 km., the contribution to the conductivity will come mainly from the ions and will be sufficient to explain the high value required by magnetic data.

In spite of its drawbacks, the 'dynomo' theory of solar and lunar diurnal variation seems to explain observations best. When Chapman first worked it out in detail, there were two main difficulties: one was that the phase of the magnetic variations did not agree with that deduced from the barometric variations at ground level and the second was that the electric conductivity demanded was much larger than that deduced from radio data. The first objection was reduced in importance by Pekeris' work on tidal oscillations in a two-layered atmosphere in which he showed that the semi-diurnal wave at 100 km. is opposite in phase to that at the ground and the second objection was met partly by Pekeris' showing that the amplitude of the 12 hourly wave at 100 km. is nearly 200 times that at the ground and partly by Massey's work on processes of recombination and attachment in the upper atmosphere wherein he gave reasons for thinking that the density of negative ions in the E region may be about 100 times that of electrons in the same region.

It may also be mentioned that owing to the increase of molecular conductivity at higher levels, the damping of tidal oscillations by conduction and viscosity will be negligible at 100 km. and will be very large at 200 km.

Diamagnetic and drift-current theories of solar diurnal variation.

Two other theories of solar diurnal variation have been proposed, a diamagnetic theory of the upper atmosphere by Ross Gunn and a drift-current theory by Chapman. According to the former, in the upper levels of the atmosphere where the time between two collisions of a charged particle is long compared with the time for a rotation of the particle round the lines of magnetic force, the particle will rotate round the lines of force in such a direction as to render the layers diamagnetic, the susceptibility depending on the density of electrons and ions and on their speeds. Assuming a suitable variation of charge density with local time, qualitative agreement with the observed field variation can be obtained, but the calculated field is too small unless temperatures of the order of 1000°C are assumed for the long free path region. According to the drift-current theory, in the region of long free paths, the charged particles fall freely under gravity and their motion being inclined to the direction of the magnetic field, they are deflected in a horizontal direction, giving rise to an eastward current over the equatorial regions. Owing to the diurnal variation of ionization, the currents will not remain parallel to the latitudes throughout the day but will diverge and converge giving rise to the observed variation of field. The theory has not been worked out in a quantitative form.

Both these theories place the seat of solar diurnal variation in the long free path region.

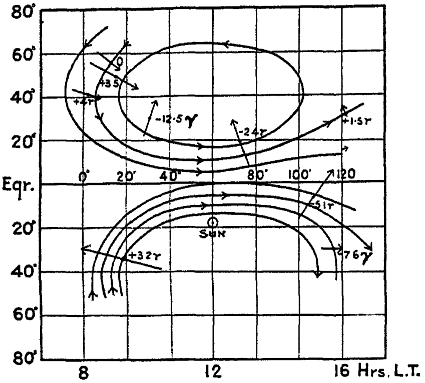
Evidence from magnetic disturbances associated with radio fade-outs.

Within the last four years, fresh evidence has appeared regarding the location of the currents responsible for the solar diurnal variations. This comes from an analysis of the magnetic disturbances accompanying radio fade-outs. In long distance short-wave radio transmission, it was noticed that occasionally the signals entirely disappeared quite suddenly and made their reappearance after a period ranging from 15 to 45 minutes. Detailed investigation by M. Jouaust of France showed that these fade-outs occurred simultaneously over different parts of the earth. J. H. Dellinger [9] of the American Bureau of Standards working in collaboration with the workers of the Mount Wilson Solar Observatory discovered that when the radio fade-outs occurred, there was a simultaneous appearance of a bright eruption on some small portion of the sun's surface (usually in the neighbourhood of a sunspot) and as the brightness of the solar eruption waned, the radio signals gradually regained their strength. It was also noticed that during the time of the solar eruptions, there appeared in the traces of self-recording magnetographs a characteristic sudden disturbance, a phenomenon which had been noticed as early as 1859 and remarked on by Balfour Stewart. To understand the character of the changes in the ionosphere responsible for these disturbances, it is necessary to study the distribution of the changes of the directions and magnitude of the magnetic field over the surface of the earth. This was done by A. G. McNish[10] for the western hemisphere. In 1936, the magnetograms of the Alibag Observatory showed 16 clear instances of such disturbances. On enquiry the Engineers of the Indian Radio and Cables Co., Ltd., supplied a list of the times of occurrence of the radio fade-outs which had been observed in India during the communication of signals between

India and England and India and Japan. On all such occasions, marked disturbances in the magnetic curves had occurred. In Fig. 3 are plotted the changes of magnetic field due to one such disturbance which occurred on January 26, 1937.* The important point to notice is that if we assume the disturbance to be due to a system of electric currents in the upper atmosphere, it is nearly of the same form and position as the system of currents required to explain the solar diurnal variations of the earth's field. This suggests that the effect of the solar outburst is to produce an increase in the ionization and hence the conductivity in and near the levels at which the ordinary quiet-day variations take place.

FIG. 3.

ELECTRIC CURRENTS IN THE UPPER ATMOSPHERE ASSOCIATED WITH THE RADIO FADE-OUT OF 26TH. JAN. 1937—BEGINNING 7h.57m. G.M.T.



The arrows show the directions and magnitudes of the changes in the horizontal field and the figures the changes in the vertical field, positive sign indicating increase in downward component.

Progress in ionospheric technique has provided means of locating the approximate level at which a sudden burst of ionization is caused by the solar eruption. During a radio fade-out, the initial cut-off of reflected waves from the ionosphere is abrupt from all the layers E, F_1 and F_2, but the waves reflected from the lower layers disappear a little earlier. The reappearance of the signals is distinctly earlier from F_2 than from F_1, from F_1 than from E and so on. When the signals have reappeared the charge-densities of F_2 and F_1 show practically no change, while the charge-density of E shows a slight increase. These facts and the rapidity with which normal conditions are restored make it certain that the ionization due to the solar flare takes place in and below the *E* layer. The current system due to the fade-out being similar to the solar diurnal variation makes us infer that the latter also is located in or near the *E* layer.

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* I am indebted to the Directors of the respective observatories for kindly sending me their original magnetograms or their copies from which this and similar charts have been prepared.

Magnetic storms.

Besides the periodic variations of the earth's magnetic field, there are irregular variations of different kinds. Some of them are of well-defined types. The most important of them is the 'magnetic storm'. In our latitudes, a 'world-wide' magnetic storm may cause changes of horizontal intensity amounting to 800 γ, or more than one-fifth the normal value of

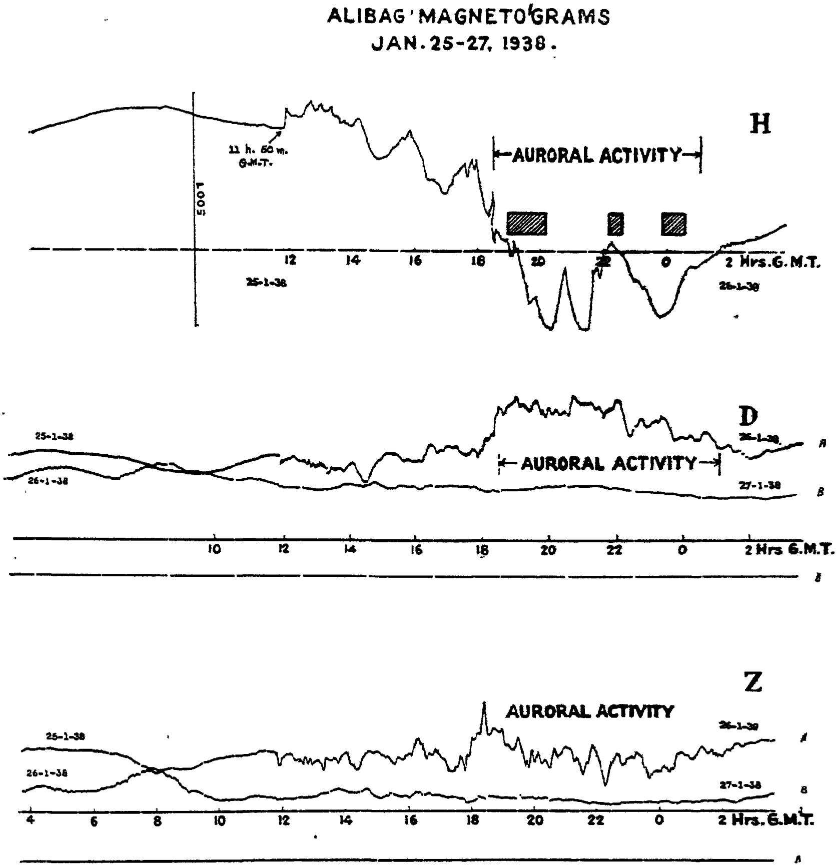

FIG. 4.

the field. The characteristic features of magnetic storms have been analyzed by Moos,[11] Chapman[12] and others. Moos made a detailed analysis of Bombay data and Chapman extended and amplified it including data from other parts of the earth. The time-variation of the magnetic elements after the onset of a storm depends to an appreciable extent on the time of the day. It can be analyzed into (1) a storm-time variation and (2) a local time variation. The local time variation consists of a diurnal oscillation, with maximum departures from normal in M and Z, the horizontal and vertical components of the field, at about 6 hrs. and 18 hrs.

Magnetic storms often begin with an impulsive change in H—generally an increase—followed by oscillations. Within an hour or two after this 'sudden commencement', follows a period of rapidly diminishing H, lasting for 6 to 12 hrs. The period of abnormally low values of H is the second or *main phase*. Finally, there is a gradual return of conditions to normal, which may go on for three or four days. (Fig. 4.)

Both the 'sudden commencement' as well as the maximum change of field during the main phase of the storm show systematic geographical distributions. The 'sudden commencement' —which is most marked in H—is generally a maximum near the equator and decreases towards the poles. Sometimes, there is an increase of intensity in the neighbourhood of the auroral zone. The maximum disturbance during the main phase also shows a decrease in the same direction, but after 60°– 65° geomagnetic latitude, the disturbance sharply rises to a maximum in all the elements. The more intense the storm, the lower is the latitude at which the sharp increase in disturbance takes place. The storm-time variations can be analyzed in a manner similar to the diurnal variations by the method of spherical harmonic analysis in order to ascertain whether the source is internal or external. The result of such a study has been to show that the main source of disturbance lies outside the earth with an internal induced system associated with it. That the outside source is a system of electric currents either in the earth's atmosphere or outside it, was the view put forward by Birkeland [13] in his classical discussion of the magnetic results of the Norwegian Aurora Polaris Expedition of 1902-03. It is desirable to consider the current systems associated with the preliminary phase and the main phase of the storm separately.

(*a*) *Preliminary phase.*

The disturbance vector is directed northward in low and middle latitudes and the sudden commencement occurs within two minutes all over the earth, on the dark side as well as the bright side. The impetus is a maximum over the equator, and there is sometimes, but not always, another maximum near the auroral zone. The current system required is an eastward flow all round the earth, and corresponds to the 'positive equatorial perturbation' of Birkeland.

Main phase.

The current system due to the main phase has been studied by Chapman[14] and his co-workers and by Goldie.[15] The system can be divided into two parts corresponding to the storm-time and the local time variations of the disturbance field. These consist of (1) a westward flow with a diffuse maximum of current density over the equator and a concentrated maximum over the auroral zone and (2) a system of four vortices, two in the northern and two in the southern hemisphere. The direction of the forenoon vortices is cyclonic and of the afternoon ones anticyclonic. The afternoon vortices are generally the more intense. The combined and component current systems (assuming them to lie in a thin spherical shell surrounding the earth) are shown in diagrams by Chapman. In the maximum storm-time phase of moderate storms, a total current of the order of 5×10^5 amperes, flows westward in extra-auroral regions and currents of the order of $3{\cdot}5 \times 10^5$ and 2×10^5 amperes flow westward and eastward respectively in the auroral zone. In very great storms, the current density may exceed ten times this amount. Chapman's scheme of electric current systems may be compared with those worked out for individual disturbances by Birkeland and for the average of 10 storms by Goldie.

Location of the currents.

There is little doubt that during the main phase of the storm, the currents *in the auroral zone* lie mainly in the earth's atmosphere. The connection between auroræ and magnetic storms is very close, great magnetic storms being associated with marked southerly movement of the auroral region (see Vestine's diagram showing average directions of magnetic disturbance vectors and of auroral arcs). The most frequent height of auroræ is in the neighbourhood of 110 km. Birkeland, from his calculations of the spatial variation of the field near the auroral region found that the heights of the currents lay between 150 and 600 km. Goldie estimated the mean heights of the currents to be 290 km. at 2 hrs. local time and 370 km. at 17 hrs. McNish[16] and Vestine in recent analysis of the heights of electric current systems due to 'polar elementary storms' and smaller disturbances have taken into account the effect of the induced field inside the earth and found that the hypothesis that fits the facts best is a current at 100–150 km., a region where the direct current conductivity of the upper atmosphere is a maximum. The probability therefore is that the concentration of magnetic field in the auroral zone during the main phase of magnetic storms is also due to a concentrated current system round the geomagnetic pole at a height of 100–150 km. above the earth flowing along auroral paths of large conductivity.

The location of the current system causing an 'equatorial perturbation' is more difficult. Various reasons make it necessary to place it well outside the earth's atmosphere. The magnetic changes are greatest in regions round the equator and the disturbing vector is directed similarly in both the northern and southern hemispheres. The facts of magnetism can be most simply explained by assuming, with Birkeland, that it is due to a ring-current round the earth with maximum intensity over the equator, the size of the ring being comparable with the diameter of the earth. The direction of the ring-current would be eastward at the time of 'the sudden commencement' and westward during the main phase of the storm. That the formation of such ring-currents is possible when a stream of charged particles flows towards a magnetized sphere was demonstrated by the laboratory experiments of Birkeland and the calculations of Störmer.[17]

An attempt at finding the position of the equatorial ring-currents has been recently made by S. E. Forbush[18] in the case of two magnetic storms, one of which began on August 21, 1936 and another on January 16, 1938. The storm-time variations of the earth's field were analyzed, assuming them to be due to (1) a westward ring-current over the geomagnetic equator and (2) two concentrated westward current systems over the north and south auroral zones, at a height of 150 km. above ground and (3) the associated induced fields. The result of the analysis as regards the position of the equatorial ring-current is shown in the following table:—

Estimated value R/a of equatorial ring-current.

Date of commencement of storm.	Time after commencement.	Estimated zonal current and polar distance.	R/a
Aug. 21, 1937	30–78 hrs.	4×10^4 amp. and 20°	4·0
	54 hrs. (adjusted by smoothing)	do.	2·5
Jan. 16, 1938	22–46 hrs. 54–78 hrs.	$6{\cdot}2\times 10^4$ and 28°	15·8
	54 hrs. (smoothed)	do.	2·1
Disturbed days minus quiet days.		2×10^4	2·3

In the case of storms, the radius of the ring-current is not less than two earth-radii, but may greatly exceed that figure. For a mean disturbed day, the radius is of the order of 2 to 3 earth-radii.

A line of study which in the near future is likely to yield valuable information regarding these ring-currents is the effect of magnetic storms on cosmic ray intensity. That there was a decrease in cosmic ray intensity throughout the earth from the equator to 50°N. during a magnetic storm was noticed by a number of cosmic ray investigators during the magnetic storm of April 26, 1937. Usually, a fall of horizontal intensity is associated with a decrease of cosmic ray intensity. It was pointed out by Chapman that this effect was probably due to the postulated ring currents and that the change in cosmic ray intensity might enable us to determine the height of the currents above the earth. While for the same storm, the changes in H and changes in cosmic ray intensity seem to be correlated, the mean ratio $\Delta J/\Delta H$ for different storms are different. For instance, in the storm commencing on August 21, 1937, there was hardly any effect on the cosmic ray intensity. This can be explained if the current systems for different storms flow at different distances. The calculated values of the radii of the equatorial current system calculated from the changes of cosmic ray intensity in three or four magnetic storms are 3 to 4 earth-radii.

A serious difficulty, however, remains. In the above calculations, it is assumed that the effect of the external current system is to increase the magnetic field outside the system and hence to decrease the number of cosmic ray particles reaching low and moderate latitudes. While this is of course true, there will be a corresponding decrease of field between the earth and the external current system and since the largest deflections of the charged particles will occur within this space, the net effect of the ring-current would, *a priori*, be expected to cause an increase in the allowed cone of cosmic rays and hence an *increase* in its intensity. Clay and Bruins[19] think that the only way to escape out of the difficulty is to assume that circular currents normally exist over the equator but that during magnetic storms, they decrease or oscillate. Detailed calculations of the effect of a ring-current on the paths of charged particles are necessary and will no doubt be forthcoming shortly.

Cause of magnetic storms.

The close correlation between magnetic and auroral activity makes it clear that the origins of the two are intimately connected. The corpuscular theory of Birkeland and Störmer explains many of the facts well and in spite of weighty objections to the theory, it appears probable that some modification of it will survive. A stream of charged particles directed from outside towards a magnetized sphere, such as the earth, will describe a series of orbits determined by the magnetic moment of the sphere and the momentum of the particles. Störmer showed that there exists, about the sphere, a toroidal space with its axis coinciding with that of the sphere, into which the particles will not enter. The equatorial radius of this space is given by $(2^{\frac{1}{2}}-1)\,C$, where $C=(Me/mv)^{\frac{1}{2}}$, M being the magnetic moment of the sphere, and e, m and v the charge, mass and velocity of the particles. C has this physical significance that it is the radius of the equatorial circle which is a possible orbit for the particle. There is thus only a limited region round the magnetic poles to which particles from outside can have entry. The maximum angular extent of this region depends on the momentum of the particles. A table showing the values of C and the maximum angular distance from the poles at which particles can enter the earth's atmosphere, is given below for various kinds of particles.

TABLE.

Nature of particles.	Velocity cm./sec.	$\frac{mv}{e}=H\rho$	C in earth radii.	Angular distance of entry (from magnetic axis).
Cathode rays	$1{\cdot}9\times 10^{9}$	108	1400	2°·3
	$9{\cdot}0\times 10^{9}$	540	660	3°·4
β rays	$2{\cdot}4\times 10^{10}$	1800	345	4°·6
	$2{\cdot}8\times 10^{10}$	4500	220	5°·8
α rays	$1{\cdot}4\times 10^{9}$	290,000	28	16°·6
	$2{\cdot}06\times 10^{9}$	398,000	23	18°·1
Ca+	$1{\cdot}6\times 10^{8}$	$6{\cdot}6\times 10^{5}$	17	20°

Even fast β ray particles with a velocity of $2{\cdot}8\times 10^{10}$ cm./sec. cannot get beyond 5°·8 from the magnetic pole. As we know from auroral and magnetic observations that the maximum current densities occur at 20–23° from the poles, the particles, if electrons, must have even greater velocities, or they should be particles of atomic size with momenta exceeding those of the fastest α rays. Milne has calculated that Ca+ atoms moving away from the sun, would get gradually accelerated owing to absorption of solar radiation from regions outside the centres of the Fraunhofer H and K lines and acquire a maximum velocity of $1{\cdot}6\times 10^{8}$ cm./sec. Such particles will reach the earth in about 28 hrs. and enter the earth at about 20° from the magnetic axis. But their momenta would be too small to penetrate to a depth in the atmosphere as low as 80–100 km.—which seems to be required by auroral phenomena. Ionospheric studies in the auroral region also point to the conclusion that the particles reach a height of 80–100 km. above ground. Leiv Harang,[20] of the Auroral Observatory at Tromsφ in Norway (ϕ=69°40′N., λ= 18°57′E.) summarizes the general results of radio-echo observations there during magnetic disturbances as follows:—

(1) Momentary formation of a new layer at the level of the E layer during storms.

(2) Formation of an absorbing layer below the usual E layer during the intense phase of the storm causing weakening and sometimes cessation of the echoes on all wave-lengths.

(3) Formation of high F layers during and after the storm with subsequent lowering of height.

(4) Decrease of the critical frequencies of F_1 and F_2.

(5) Rapid changes of $P'f$ curves in periods of magnetic activity.

It has been suggested by Störmer and demonstrated experimentally by Brüche that if there is a ring-current round the earth, its effect would be to shift the position of entry to nearer the equator. If the observed position of the auroral zone is to be explained in this manner, we should expect that the position of maximum disturbance should depend on the strength of the ring-currents, that is, on the strength of the disturbance. It is true that during large disturbances, there is a tendency for the zone of maximum disturbance to shift equatorward, but during

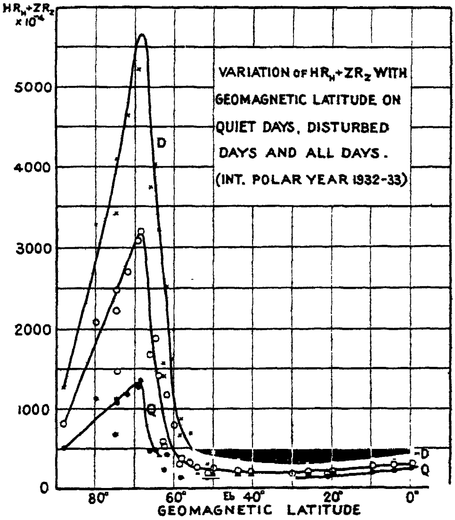

FIG. 5.

weak disturbances, no such tendency seems observable. This may be seen from Fig. 5 in which is shown the variation of disturbance with distance from the magnetic equator on all days, quiet days, and disturbed days prepared from the range data published by the International Commission for Terrestrial Magnetism.

Birkeland and Störmer considered the stream of corpuscles projected from the sun and moving towards the earth as having charges of the same sign. It is now generally agreed that such a stream would not hold together all the way from the sun to the earth without dissipation. Chapman and Ferraro have attempted to work out a detailed theory of magnetic storms and auroræ, assuming the particles to be neutral on the aggregate but composed of equal numbers of positive and negative charges and probably also accompanied by a good number of uncharged particles. Such a composite stream can approach the earth much nearer than a stream of particles all having the same sign; and if a moderate difference in speed between the positive and negative particles is permissible, it is possible for them to form a ring-current round the earth; but, as Chapman says, 'It must be confessed that we have no clear indication whether or how such a ring could be formed'. However, present-day evidence is tending more and more to the view that an equatorial ring-current is formed outside our atmosphere.

Such a ring-current, when varying, must produce induced currents in our atmosphere; and the question remains to be answered whether we can explain all the effects that we observe in low latitudes during magnetic storms by the effect of the induced currents in a non-uniformly conducting atmosphere. For example, there is the local time variation of magnetic storms. Again, ionospheric workers in moderate latitudes also have found that during magnetic storms, the waves reflected from the F_2 region become weaker, the height of this region increases and its electron density decreases. Observations are obviously needed from low latitudes of the changes that take place in the upper atmosphere during magnetic storms. Some observations perhaps do exist, but they have not become available.

Before leaving the subject, it is desirable to consider briefly a purely atmospheric theory of magnetic storms worked out by Hulburt and Maris.[21] They assume that in times of activity, the sun occasionally emits a sudden blast of ultra-violet radiation lasting for a short period, mainly in the region of wavelengths below 1500Å. The radiation produces ionization both in the long and short path regions of the sunlit atmosphere. According to them, therefore, the particles do not come from outside; they are produced in our atmosphere mainly in low latitudes. The ionization in the long free path region produces an eastward current and gives rise to the initial phase of the storm with its increase in H. The ionization in the short free path region increases the conductivity of the atmosphere and causes its expansion; and upward velocity of 10 km./hr. can cause a decrease in H of 100 γ at the equator. The expansion is also supposed to engulf the long free path ions in the rising tide of molecules and convert them into short free path ions. The consequent reduction in the number of long free path ions is believed to be responsible for the observed after-effect of the storm in keeping down the horizontal component of the earth's field below normal for a few days. The most serious objection to the ultra-violet theory is, as pointed out by Chapman, that the ultra-violet theory can account for a velocity of only about 10^6 cm./sec. for the particles by ultra-violet ionization and impact with excited particles and that this velocity is far too small for the particles to penetrate down to 80 km. and explain the various observed features of auroræ.

Conclusion.

From what has been said, it will be clear that the subject of Terrestrial Magnetism presents many problems of great interest both to the experimental and the theoretical physicist. We are still far from the solution of the fundamental problem of the origin of the earth's permanent magnetic field. More information can undoubtedly be gathered about the electrical and magnetic properties of the earth's interior by a study of the magnetic variations on the lines of Chapman and his school. I have not even touched on the application of magnetic methods to the study of the structure of the top layers of the earth's crust—a method which has given results of economic value in other countries and has begun to yield results of great geophysical interest in the hands of the Survey of India. Our knowledge of the exact locations in the earth's interior and in the atmosphere, of the sources of regular and irregular variations of the earth's field is still very incomplete. The question of the existence, permanent or otherwise of a system of ring-currents round the earth is still a matter for discussion.

It has been said that the sun and stars provide us laboratories in which experiments on matter are carried on under conditions of temperatures and pressures which can never be realized in the laboratory. So too our mother Earth provides us a magnet of stupendous dimensions with which various experiments on matter are being continuously carried on and it is for us to observe and collate the results and reason on them so as to know a little more about her and about matter in general.

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SECTION OF CHEMISTRY

President :—P. B. SARKAR, Dr.es Sc., A.I.C., F.N.I.

Presidential Address

ANALOGY AMONG CHEMICAL ELEMENTS AND RADICLES.

LADIES AND GENTLEMEN,

Inasmuch as I appreciate the honour of being called upon to preside over the deliberations of the Chemistry Section of the Indian Science Congress of this session, I am equally conscious of the responsibility of this onerous task,—a responsibility great enough to make a man feel uneasy. But in my own case it has been doubly great due to continued ill health. I am, however, encouraged by the thought that I can count on your kind co-operation and forbearance.

As for the subject of my discourse, I propose to speak on 'Chemical Analogy'. Analogy, as you are all aware, has played a significant rôle in the development of science. As a recent instance I may mention that it was the analogy of dual character of radiation as photon and wave that led de Broglie to formulate his famous wave theory of matter which was soon beautifully confirmed by experiments. It is not for me to dwell upon the great generalization in physical science resulting from this theory of wave mechanics. In our own science, the method of analogy has been even more fruitful. The study of analogy in the chemical and physical behaviour of the elements led Mendelejeff to establish the Periodic Law, which has inspired almost all chemical investigations of any significance. Following the same method, Mitscherlich discovered his well-known Law of Isomorphism which has placed in our hands a very useful method of determining atomic weights of elements. Analogy revealed by the Periodic Law enabled Mendelejeff to predict the discovery of many new elements which were unknown at his time, and we are all aware how these predictions have been wonderfully fulfilled.

Investigation as to the cause of this analogy among chemical elements has led at different times to many hypotheses till the discovery of the structure of atoms has cleared up the issue. It might be asked what is the criterion by which to determine that two elements are chemically similar or analogous? The question may be answered in many ways. Geoffrey Martin[1] has suggested the following standard:—

'Chemically similar elements attract the same radicles with proportional intensities of forces, whereas chemically unlike elements attract them with unlike intensities.

'Expressed mathematically,—if an element A attracts the elements C, D, E, F, G .... with affinity strengths $f_1, f_2, f_3, f_4, f_5 \ldots.$, and if another element B attracts the same radicles with affinity strengths $f_1', f_2', f_3', f_4', f_5', \ldots$, then if A and B are similar elements

$$\frac{f_1}{f_1'} = \frac{f_2}{f_2'} = \frac{f_3}{f_3'} = \ldots.. = \frac{f_n}{f_n'} = k \text{ (constant).'}$$

The cause of chemical similarity is, however, to be sought in the similarity of the structure of the valency shells, which also accounts for the analogous physical and optical behaviour in many cases. Thus the alkali metals not only behave chemically in a similar way but they also give similar dual spectra. A very interesting case of analogy among elements is offered by univalent thallium which, in its hydroxide, carbonate and sulphate, resembles the alkali metals, and in its oxide, sulphide and halides resembles silver closely. If we consider the valency shell of thallium, silver and the alkali metals, we shall notice certain resemblances and differences. The valency shell of thallium consists of three electrons in the sixth quantum group of which two are *s* electrons and one a *p* electron and these occur after the eighteen electrons of the fifth quantum group filling up the *s*, *p* and *d* sub-levels. In silver, on the other hand, we have only one *s* electron in the fifth quantum group occurring after eighteen electrons of the fourth quantum group filling up the *s*, *p* and *d* sub-levels. In the alkali metals there is only one *s* electron in the outermost valency shell occurring after the inert gases which latter, with the exception of helium, are all characterized by having an outer valency shell of eight electrons, and of these two are *s* and six are *p* electrons. This is illustrated in the following table:—

Quantum numbers.		I	II	III	IV	V	VI	
							s	*p*
37 Rb	..	2	8	18	8	1		
47 Ag	..	2	8	18	18	1		
81 Tl	..	2	8	18	32	18	2,	1

When both the *s* electrons and the single *p* electron of thallium in its outermost shell are removed, thallium behaves as a tervalent element and resembles Al or Ga in its behaviour. But under suitable conditions the completed *s* sub-level may remain undisturbed and the single *p* electron alone behaves as the valence electron. Under these circumstances thallium can behave, curiously enough, both like alkali metals as well as silver. But the analogy cannot be so close as between potassium and rubidium, or between copper and silver. Anyway, the equality of valency here gives rise to chemical similarity. Equality of ionic volumes and polarization factors are also calculated to contribute sometimes to a measurable extent in this direction. Thus the ionic volumes of univalent thallium, rubidium and silver, as given by Goldschmidt[2], are respectively 1·49, 1·49 and 1·13 A.U. We thus find that in perfectly ionic compounds like hydroxides, sulphates and carbonates, thallous salts closely resemble those of rubidium. But in the case of oxides, halides and sulphides, where thallium tends to form covalent compounds due to the deformability of oxygen, sulphur and halogen ions resulting in the diminution of interionic distances it resembles silver.

Scandium and yttrium are generally classed with the rare earths because of analogous chemical behaviour. This is evidently due to analogous character of outer electronic shells as given in the following table:—

Quantum numbers.	I	II	III	IV	V	VI
21 Sc ..	2	8	9	2		
39 Y ..	2	8	18	9	2	
57 La ..	2	8	18	18	9	2
58 Ce ..	2	8	18	19	9	2
59 Pr ..	2	8	18	20	9	2
etc., etc.						

The penultimate shell of 9 and the ultimate shell of 2 electrons are common to all of them. Hence the analogy among these elements are much closer than that of the previous case of rubidium, thallium and silver. The difference in the structure of the fourth quantum group, lying deeper inside the atom in the case of the rare earths La, Ce, Pr, etc. does not affect their chemical properties to any measurable extent.

Scandium has also been found[3] to resemble the iron family of elements so far as the crystalline form and the chemical composition of the hexa-coordinated complexes are concerned. Mixed crystals of acetylacetonates of iron and scandium have been prepared; so are the double sulphocyanides with alkali metals isomorphous with the corresponding chromium compounds. Double oxalates of scandium and sodium are isomorphous with sodium aluminium oxalate. A series of double sulphates with alkali metals corresponding to the anhydrous alums have also been described. Some of the basic nitrates of scandium are similar to those of iron and chromium.

In solubility of its simple salts scandium, however, resembles the rare earth elements more closely. Like the rare earths, scandium forms insoluble oxalate and fluoride.

Scandium constitutes the first member of the first transitional group of elements in the periodic table and is followed by titanium, vanadium, chromium, manganese, iron, etc. Their electronic structures are shown in the table below:—

Quantum Numbers.		I	II	III	IV
21 Sc	..	2	8	8+1	2
22 Ti	..	2	8	8+2	2
23 V	..	2	8	8+3	2
24 Cr	..	2	8	8+4	2
25 Mn	..	2	8	8+5	2
26 Fe	..	2	8	8+6	2

The resemblance in this case is also due to the equality of valency (tervalency), the electrons in the penultimate group exerting at times less marked influence on the properties of the ions.

The analogy in the cases discussed above, caused only by the similarity of the outermost electronic shell with the structure of the penultimate shell varying, is therefore, to a certain extent incomplete, as differences in their chemical and physical properties in many other respects are quite appreciable. Thus, for instance, tervalent iron resembles tervalent manganese, but the latter is very unstable and readily changes into bivalent manganese ion, whereas ferric ion is quite stable to which the less stable ferrous ion readily reverts.

In cases where the structures of both the ultimate and the penultimate shells are similar, as in elements of the same vertical group of the Periodic Table (excluding the elements of the transitional groups), the analogy is more perfect or complete; e.g., the alkali metals, the halogen elements, chalcogenides, etc. Lithium, as is well known, differs somewhat from the other alkali metals, and so also fluorine and oxygen from their homologues due to a difference in the structure of the penultimate shell.

A complete analogy is also observed in the series of the rare earth elements; because, as already stated, the structures of both the ultimate and the penultimate shells are similar; the difference in structure of the pre-penultimate shell lying deeper inside the atom exercises little influence on their properties. This is the reason why the problem of the isolation of individual rare earth elements presented a heroic task to the investigators. As a matter of fact their individuality was doubted in the beginning and they were named 'meta-elements' by Crookes.[4] Some of these rare earths were discovered as early as 1800 A.D., and a closer examination of this group of elements in the beginning of the 19th century was made by Klaproth, Berzelius (both discovered the cerite earths simultaneously), Gadolin (discoverer of yttrium earths, by whose name gadolinium is known), Clève (the element holmium is named after his native city) and Mosander (discoverer of lanthanum). For nearly 50 years after this, no notable progress was made in the study and isolation of the individual elements. Only towards the end of the 19th century the investigations of these elements were taken up with renewed vigour, and specially by Auer von Welsbach, of gas mantle fame, Nilson, the discoverer of scandium, Clève, the discoverer of thulium, Demarçay, Lecoq de Boisbaudran, Urbain, James and Hopkins.

On account of the close analogy, these elements are found intimately associated together in nature and have not been separated by long-continued geochemical processes. As a result, their isolation and investigation are marked by a very slow process continued for generations and are far from complete solution even at the present moment. The discovery of spectro-analytical methods in 1860, the formulation of Periodic Law in 1868, and the technical application of the rare earths by Auer von Welsbach in the eighties furnished great impetus to the study of these elements. The method of fractional crystallization, employed by Mosander in 1843 formed indeed the basis of all further work in the isolation of these closely analogous group of elements. Their separation by elaborate fractional crystallization has been possible because of their isomorphous character, as isomorphous substances rarely form non-separable mixtures on crystallization. The method of X-ray spectroscopy developed by Moseley (1913) and the interpretation of the Periodic Table on the basis of atomic structure by Bohr (1922) have been of great consequence in the interpretation of rare earth chemistry; as a result of these, we now know them as separate individual elements with distinct atomic number in spite of close analogy in their chemical and physical properties.

Molecular Volumes of sesquioxides (Crystal type *C*).

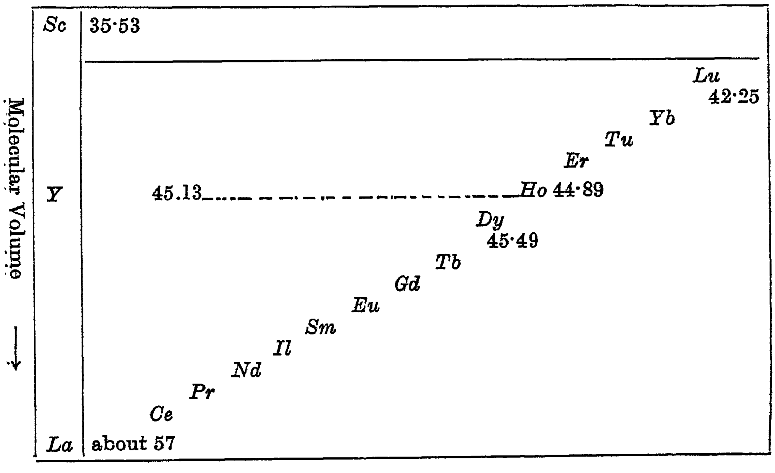


FIG. 1.

Limited resources of analytical methods available for the study of these analogous elements led frequently to false conclusions about the composition of their mixtures. The introduction of optical spectroscopic method supplied an analytical method of great usefulness, but the influence of the presence of impurities on the excitation and intensity of individual lines in the spectra in certain cases often misled the investigators. Instances of such erroneous conclusions in the history of the study of rare earths are not rare. Mention may be made here of De la Fontaine's philippium (a mixture of yttrium and terbium earths) as well as his decipium, the meta-elements of Crookes, metacerium of Brauner, splitting up of lanthanum and cerium by Schutzenberg, Eder's welsium, etc.

We can now account for the chemical analogy of the rare earth elements on the basis of their electronic structure, which remains practically unaltered in the ultimate and penultimate shells; additional electrons with the increase of atomic number enter one after another into the interior 4_4 shell, which is shielded from external influences. However, in spite of these, they can be differentiated from one another by certain interesting properties, some of which are being described here.

As the outermost shell of the electron remains unaltered even with the increase of atomic number or nuclear charge, there is a

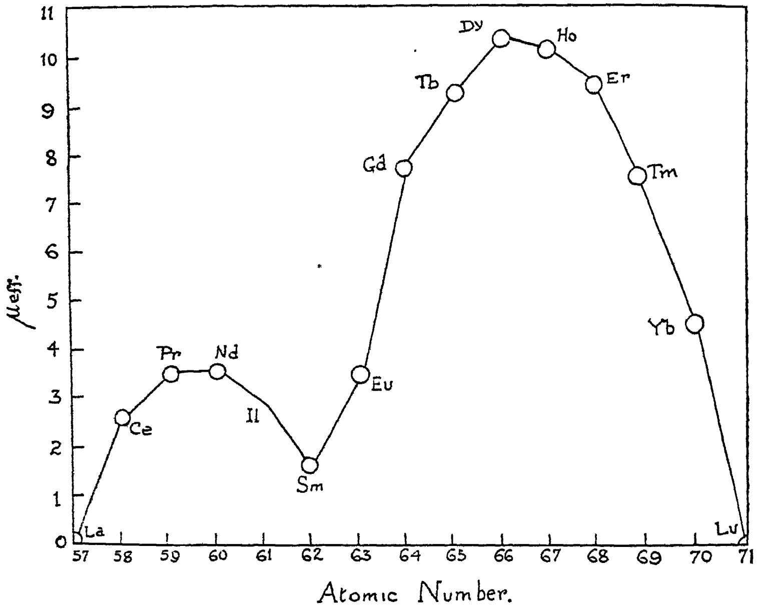


FIG. 2. Effective Bohr Magneton Numbers of the Rare Earth Trivalent Ions at Room Temperature.

gradual contraction of the atomic volume due to the increasing strength of binding of the valence electrons. This is known as Lanthanide Contraction of Goldschmidt.[5]

From this it is evident that yttrium comes between dysprosium and holmium, and scandium will follow lutecium in basic character. This fact also accounts for the slow decrease of their basicity from lanthanum to lutecium on the basis of which one of the methods of their separation has been developed.

The magnetic properties (paramagnetic susceptibility) of the ions of the rare earths also differ considerably from each other. This evidently depends upon the number of electrons of the 4_4 shell, which is gradually filled up. This is shown in Fig. 2. This has served as an important criterion for testing the purity of the individual rare earth compounds during their separation.

Absorption spectra and colour, also a function of the electronic structure, differ for the individual rare earths. As has been pointed out by Main Smith[6], the rare earths show a sequence of colour in that the colour of the first seven normal ions are repeated in those of the last seven in the reverse order (see table).

Colour Sequence of the Rare Earth Ions.

Trivalent ions.	Colour	Ions of other valency.
La	colourless	
Ce	colourless	Ce^{++++}—red.
Pr	green	Pr^{++++}—black.
Nd	red	
Il	yellow ?	
Sm	yellow	Sm^{++}—brown.
Eu	faint pink	Eu^{++}—colourless.
Gd	colourless	
Tb	faint pink ?	Tb^{++++}—brown.
Dy	yellow	
Ho	yellow	
Er	red	
Tm	green	
Yb	colourless	Yb^{++}—green.
Lu	colourless	

Formation of ions of anomalous valency by certain rare earths is of considerable interest. Equality in the magnetic susceptibility of bivalent samarium with that of trivalent europium, the next higher element, of Yb^{++} with Lu^{+++}, of Ce^{++++} with La^{+++}, of Pr^{++++} with Ce^{+++}, and of Tb^{++++} with Gd^{+++} indicates an isoelectronic arrangement (see table).

Total No. of electrons.	No. of electrons in 4_4 shell.	Divalent.	Trivalent.	Quadrivalent.
54	0	..	La^{+++}	→ Ce^{++++}
55	1	..	Ce^{+++} ↗	→ Pr^{++++}
56	2	..	Pr^{+++} ↗	
57	3	..	Nd^{+++}	
58	4	..	Il^{+++}	
59	5		Sm^{+++}	
60	6	Sm^{++} ←	Eu^{+++}	
61	7	Eu^{++} ←	Gd^{+++}	→ Tb^{++++}
62	8	..	Tb^{+++} ↗	
63	9	..	Dy^{+++}	
64	10	..	Ho^{+++}	
65	11	..	Er^{+++}	
66	12	..	Tm^{+++}	
67	13		Yb^{+++}	
68	14	Yb^{++} ←	Lu^{+++}	

Use is made of these anomalous valencies in the separation of these closely similar substances which form isomorphous compounds in their normal ionic stage. Thus cerium has long been separated effectively from other rare earths in a single step as ceric compound. Similar methods for the separation of Tb and Pr have also been attempted. Bivalent Eu and Yb resemble Ba and Sr and form insoluble sulphates. This serves as an elegant method for the isolation of Eu and Yb, which marks a distinct advance in rare earth chemistry, as hitherto it was practically impossible to isolate these two in the pure state.

Trivalent bismuth has been observed to show many similarities with the rare earths. Isodimorphism of hydrated bismuth nitrate with the rare earth nitrates and the isomorphism of the double nitrate of bismuth with the corresponding compounds of the rare earths of the type $2\ M(NO_3)_3 . 3X(NO_3)_2 . 24H_2O$, where $M = Bi$ or ΣLa and $X = Mg$, Zn, Ni, Co or Mn, have been utilized for the isolation of pure Eu, Gd and Tb by Urbain.[7] Triple nitrites of bismuth of the type[8] $X_2\ Y\ Bi\ (NO_2)_6$, where $X = NH_4$, K, Rb, Cs and Tl, and $Y = Li$, Na or Ag, have analogous triple nitrites of rare earths (La, Ce, Pr, Nd, Sm and Gd) with caesium.[9]

Bivalent lead is known to resemble Sr^{++} in certain respects. This is evidently due to this equality of charge and ionic radii (Pb^{++} = 1·32 Å and Sr^{++} = 1·27 Å). Strictly speaking, ions may be classified into six different types according to their structure.

1. Those with two electrons in the outer shell: H' and cations of the first period.

2. Those with eight electrons in the outer shell: the negative ions and ions of the A subgroups of the Periodic Table, excluding the transitional elements.

3. Ions of the transitional elements containing eight to eighteen electrons in the outer shell.

4. The ions of the B subgroups, containing eighteen electrons in the outer shell.

5. Some ions of the B subgroups with (18+2) electrons in the outer shell: In^{I}, Tl^{I}, Sn^{II}, Pb^{II}, Sb^{III} and Bi^{III}.

6. Ions of the rare earth elements with eight electrons in the outermost shell and 18 to 32 electrons in the underlying shell.

Ions of identical outer shell will naturally exhibit close analogy among themselves. Cartledge[10] claims to obtain a more comprehensive representation of the properties of compounds by taking account of the *charge*, *structure* and *size* of the ionic components of the compounds. He has thus developed a form of representation in which it is possible to include all the valence forms of all the elements. This is regarded as a periodic classification of ions as distinct from that of the atoms. According to him no single atomic characteristic furnishes in a broader and quantitative sense, an adequate basis of classification of the elements. He has therefore introduced a new function, the ionic potential, which is the ratio of the ionic charge to its radius, and used it as a quantitative basis for the classification. It is shown that the ionic potential is related to many characteristics of ions and their compounds and that the properties of the ions are definitely related to the structure of the outermost electronic shells, with respect to the completeness or incompleteness of these shells. A new definition of the periodic families is given on this basis.

The rôle of the ionic radii has been emphasized also by Grimm[11] and by Hevesy.[12] Grimm has suggested a periodic classification in which the direction of variation in radii is clearly represented.[13]

Having now discussed the analogy among simple ions, I would now proceed to deal with the properties of complex ions or radicles. As we shall presently see, the size of the ion plays an important rôle here, besides its charge and the number of its constituent atoms. There are even cases where equality of sizes or ionic radii brings forth analogy between two ions irrespective of the number of their constituent atoms, a very significant instance of which is furnished by K^+ and NH_4^+ ions. Analogy among radicles is generally judged by their power to form isomorphous compounds with one and the same opposite ion. Hence isomorphism often serves as a criterion of chemical analogy or homology among radicles or complex ions. But Mitscherlich's law of isomorphism, if restricted only to similar crystalline form, is not always a reliable guide. This law is neither more nor less certain than Avogadro's law. The two laws have certain points in common. That of Avogadro teaches us that under same conditions of temperature and pressure, all gases have the same molecular volume. This aphorism would not have any sense if all gases could not be compressed or dilated approximately in the same way. However, Mitscherlich's law implies at least in case of syncrystallization equality of molecular volumes, equality of coefficient of dilatation, compression, as well as equality of molecular heats. These relations bring into relief the importance of energetic coefficients in matters of chemical analogy. Starting with the theory of Duhem, one can show by thermodynamical treatment that syncrystallization implies equality of all thermoelastic coefficients. On the whole, substances capable of forming mixed crystals must possess very closely similar chemical properties. Isomorphism, defined in this sense, serves as the best criterion for chemical analogy among radicles and ions. Hence it should be emphasized here that not only the similarity in crystalline form but also the ability or otherwise for syncrystallization should be taken into consideration in deciding upon chemical analogy of radicles and compounds. We shall come across with instances where homeomorphous substances are incapable of forming mixed crystals, and are not chemically analogous. Thus, for instance, potassium nitrate and strontium carbonate have got similar crystalline forms, both being orthorhombic bipyramidal. But we know that nitrate and carbonate ions are not chemically analogous, though they are isosteric (i.e. having the same number of electrons arranged in the same way) as shown by Langmuir.[14] Langmuir has shown that isosterism is the cause of homeomorphism or isomorphism in its widest sense.

Goldschmidt[15], who has carried out elaborate investigations on the relationship between crystal structure and the chemical and physical properties of crystals, has formulated some important laws and rules which govern this relationship. This has been possible by the application of X-ray methods for the analysis of crystal structure of chemical substances. He has laid down the following determining conditions for the crystal structure of a given substance of a heteropolar nature:

> 'The structure of a crystal is determined by the ratio of numbers, the ratio of sizes and the properties of polarization of its building stones. As the building stones of crystals we visualize atoms (or ions) or groups of atoms.'

The phenomenon of polarization is best explained on the assumption of ionic deformation as shown by Fajans.[16] When a cation and an anion exist side by side, a certain amount of the negative charge of the latter is drawn towards the cation by its positive charge, and a certain amount of the negative shell of the cation is repelled from the anion. In other words, electronic orbits of both the ions are deformed. If there be more than two ions, as in a crystal, this will happen simultaneously in several directions in space. The ultimate effect of deformation or polarization is the shifting of negative charge from anion towards cation. In extreme cases of strong polarization, the electronic shell of the anion may enclose the cation and the ionic bond may pass over into covalent or atomic binding. But if the negative charge is drawn wholly over to the cation and unites with the latter, neutral atoms will result. If the negative charge leaves the anion but does not combine with the cation, then it will behave as metallic electrons vibrating between the two. In any case it becomes apparent that polarization will lead to a reduction of molecular volume.

Fajans has shown that—

(i) The deformability of ions increases with increasing atomic numbers either in the same vertical group, or in the same horizontal row of the Periodic Table.
(ii) An anion is more deformable than a cation; and the greater the charge of the anion, the greater is its deformation.
(iii) A cation is very little deformable; but its deforming power is considerable and increases with its charge and diminishes with its volume.
(iv) The deformability of an ion increases with its volume.
(v) Cations with no inert gas structure are more powerfully deforming.

Goldschmidt[5] has demonstrated in his comprehensive investigation on crystal structure how the phenomenon of polarization greatly influences the crystalline form of substances.

The law stated above is the fundamental law of crystal chemistry. Atomic weight is of little importance in crystal chemistry, it is the volume of the ion or the atom which is more fundamental. On this basis, the analogy between Tl^+ and Rb^+, Pb^{++} and Sr^{++}, Bi^{+++} and Y^{+++} can be readily accounted for.

But isomorphism in its widest sense, i.e. homeomorphism, demands a close analogy of chemical formula (i.e. similarity in the ratio of numbers). But all substances of the same type of formula are not isomorphous. Thus, for instance, NaCl is not isomorphous with CsCl; TiO_2 is not isomorphous with SiO_2. Analogy is required not only as to the numbers but also as to the properties of particles,—i.e. the ratio of their sizes and their properties of polarization.

As has already been stated, the nearest degree of isomorphism is represented by syncrystallization, i.e. formation of mixed crystals and solid solutions. This capacity for syncrystallization furnishes a reliable criterion for chemical analogy between ions, radicles and compounds, and is found when ionic or atomic distances of interchangeable constituents do not differ by more than 10% in order. This is known as the 'tolerance limit' and agrees with that permissible for thermal disarrangement. It is known that calcium and magnesium salts are not isomorphous, nor are sodium and potassium salts; but magnesium salts are isomorphic with cobalt and nickel salts.

For the purpose of chemical analogy, it should once again be emphasized that it must be assured that the conditions of 'real' isomorphism are satisfied. The word 'real' implies an analogy much more profound than that of simple exterior form. One of the characteristics of real isomorphism, as stated above, is the formation of mixed crystals, which can, at least within certain limits, admit of infinite variation in compositions. The crystallization in all proportions is a particular and extreme case of the preceding. When this character accompanies an absolute identity of form, the isomorphism is perfect. But this conception has its limitations. In fact, the crystals of two isomorphous salts are never rigorously identical; the corresponding angles always present slight differences. That isomorphism reveals most profound chemical analogies is best exemplified by the family of rare earths. Their salts of the same type have always the same crystalline form and form mixed crystals in all proportions.

As there are homologous elements, so there are also homologous radicles. Certain interesting cases of homologous radicles may be discussed here. Among the well-known instances of chemical analogy between the complex ions or radicles, those of sulphate (SO_4'') and chromate (CrO_4''), or of manganate (MnO_4'') with sulphate may be cited. Sulphate and selenate (SeO_4''), as is well known, also form a closely analogous pair. Potassium manganate forms anhydrous crystals isomorphous with potassium sulphate; sodium manganate forms decahydrated crystals like sodium sulphate with which it is isomorphous. Barium manganate is sparingly soluble in water like barium sulphate.

Analogy in all these cases may be attributed to the equality of ionic charge or valency, approximate equality of ionic volumes and similarity of electronic structures of their valency shells. There is a completed octet around each atom in these complex ions. The ionic radii of the central ions—S, Se, Cr and Mn—of these radicles are given by Goldschmidt[15] as follows:

$$S^{6+} = 0{\cdot}34\ \text{Å};\ Se^{6+} = 0{\cdot}3-0{\cdot}4\ \text{Å};\ Cr^{6+} = 0{\cdot}3-0{\cdot}4\ \text{Å}.$$

Ionic radius of Mn^{6+} is not known but as it must be less than that of Mn^{4+} which is 0·52 (Goldschmidt) it may be assumed to have a value approximating to that of S^{6+}. In all the above complex ions, the central ion is supposed to be in a hexavalent positive stage.

Permanganates also show analogy with perchlorates, as certain permanganates form mixed crystals with the corresponding perchlorates to a limited extent.

Lange[17] has studied the resemblance of the fluorosulphonate with the perchlorate ion, with respect to their chemical and crystallographic relationships. He has succeeded in preparing mixed crystals of fluorosulphonates of caesium, potassium, lithium, tetramethylammonium and the copper pyridine complex with the corresponding perchlorates and permanganates. S^{6+} and Cl^{7+}, both having the neon configuration, presumably possess equal or approximately equal ionic radii; and F^- and $O^=$ ions have almost the same ionic radii. Consequently, SO_3F' shows close chemical analogy with ClO_4'. It is assumed here that $O^=$ and F^- ions are linked to the central ions of the complexes by co-ordination bonds.

Dörfurt and Balz[18] have shown that fluoborates and perchlorates are closely analogous in their chemical and crystallochemical behaviour. They form a complete series of isomorphous salts. Further, the analogy between BF_4', ClO_4', MnO_4' and other univalent negative ions with four-coordinated central atom, such as SO_3F' and CrO_3F' has been established with the preparation of a whole series of new types of isomorphous salts. Not only this, a nitrosyl fluoborate $NOBF_4$, analogous to nitrosyl perchlorate $NOClO_4$ has also been prepared.

The analogy of difluophosphate ion PO_2F_2' with SO_3F' and ClO_4' has also been investigated by Lange.[19] Thus we find that the complex ions or radicles like $\overset{III}{B}F_4'$, $\overset{V}{P}O_2F_2'$, $\overset{VI}{S}O_3F'$, $\overset{VII}{Mn}O_4'$ and $\overset{VII}{Cl}O_4'$ exhibit close chemical similarity, though their central atoms belong to different groups of the Periodic Table.

The ionic radii of the constituent ions of these complexes are shown in the following table:

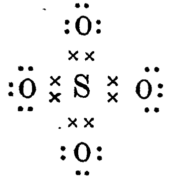
O^{2-} —1·32 Å (G)
F^- —1·32 Å (G)
B^{3+} —0·20 Å (P)
P^{5+} —0·34 Å (P)
S^{6+} —0·34 Å (G)
Mn^{7+} —0·46 Å (P)
Cl^{7+} —0·26 Å (P)

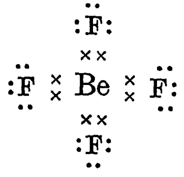
G = Goldschmidt.
P = Pauling.

Substitution of oxygen ion by a fluorine ion in the complex does not affect the size of the radicle. Complexes with S^{6+} and P^{5+} as the central ions, due to equality of their ionic radii, will show close chemical resemblances, as is actually the case. The only difference will be in the stability of the complex ions—the central ion sulphur with a higher charge will hold the negative constituents of the complex more firmly than the central phosphorus ion. Hence fluorosulphonate ion will hydrolyse to a less extent in solution than the difluophosphate. For the same reasons, the analogy between the fluoborates and perchlorates, as is actually observed, will be very close, and the stability of the perchlorate ion with the highly positive central chlorine ion will be much greater than that of the fluoborate ion which partially hydrolyses in aqueous solution. Though permanganate and perchlorate, both form quite stable ions, the stability of the perchlorate should exceed that of permanganate because of the smaller ionic radii of Cl^{7+} ion, the electric potential of the latter being higher as the charge is distributed over relatively small sphere. Though the ionic radii of Mn^{7+} and Cl^{7+} differ to a considerable extent, the percentage difference in the ionic radii of Mn^{7+} and Cl^{7+} is considerably reduced by their association with four oxygen ions of comparatively much larger volume. They are known therefore to form mixed crystals within certain limits and show a certain degree of chemical resemblances. The same reasoning holds good for difluophosphate and perchlorate ions, the latter being more stable. The actual ionic radii of BF_4', SO_3F', and ClO_4' have, however, been determined by Hassel and Kruigstad[20]; their values are 2·28, 2·37, and 2·36 Å respectively. These are very nearly equal though the ionic radii of the central ions differ appreciably. This is indicative of strong polarization effect of highly charged central ions.

In our own laboratory, we have studied the chemical analogy between the sulphate and the fluoberyllate ions.[21] It is found that beryllium is only partially precipitated by ammonia from a strong solution of ammonium beryllium fluoride. This observation evidently justifies the assumption that beryllium exists in the solution at least partly in the form of a complex ion. This was supported by a transport experiment. This indicates that in aqueous solutions of potassium or ammonium beryllium fluoride, K_2 or $(NH_4)_2 BeF_4$, the ion BeF_4'' exists though partially dissociated into its constituents Be^{++} and F' ions.

If we now consider the structure of this complex BeF_4'' ion and the ionic radii of its constituents, we shall find a close similarity between these and the corresponding magnitudes of the sulphate ion. The structure of these two ions may be represented as





All the atoms in these complexes complete their octets and assume the neon configuration. Hence, according to

Langmuir, they are isosteric, and their charge being identical, they are isoelectric as well. Hence it may be expected that they would exhibit close relationship in chemical and physical properties. The molecular volumes of $(NH_4)_2$ BeF_4 and $(NH_4)_2$ SO_4 are 74·78 and 71·90 respectively at 30°C. In fact, Barker[22] cited in his examples of unexplained isomorphism the case of potassium sulphate and potassium beryllium fluoride, their crystallographic constants as given by him approach each other very closely :—

	a		*b*		*c*
K_2BeF_4 ..	0·5708	:	1	:	0·7395
K_2SO_4 ..	0·5727	:	1	:	0·7418

The ionic radii of S^{6+} is, as already stated, equal to 0·34 Å, that of Be^{++}, according to Goldschmidt[15], is also equal to 0·34 Å. It has been stated before that the $O^=$ and F^- ions have got almost the same ionic radii. The only difference between the two central ions lies evidently in their polarizing power. The sulphur ion with its six positive charges, will be more powerfully deforming than beryllium ion with its two positive charges. This will result in a lower stability of BeF_4'' ion, which is actually the case. A series of isomorphic simple and double sulphates and the corresponding fluoberyllates have been prepared.[23] In almost all cases, the fluoberyllates resemble the corresponding sulphates both in physical and chemical properties. Their molecular volumes, where determined, were found to be comparable with those of the corresponding sulphates. In solubilities also, they resemble each other and they possess similar chemical formula. The fluoberyllates of the alkali metals, tetramethylammonium, copper, zinc, cadmium, iron, cobalt, nickel, etc., are soluble in water like their sulphates, whereas the fluoberyllates of lead, calcium, strontium and barium are sparingly soluble in water. Sodium fluoberyllate, on the other hand, prepared at the ordinary temperature, is anhydrous, unlike sodium sulphate. This is evidently connected with the lower thermal stability of the hydrated fluoberyllate, due to a smaller charge on the central beryllium ion. Wherever possible, mixed crystals of fluoberyllates with the corresponding sulphates have been prepared. X-ray spectrum of barium fluoberyllate crystals is practically indistinguishable from that of barium sulphate.[23] The double fluoberyllates like the corresponding double sulphates, are soluble in water, and form mixed crystals with the latter. Though pure alkali aluminium fluoberyllates corresponding to alums have not been obtained, mixed crystals of alums, containing both sulphates and fluoberyllates have been prepared, and the preparation of an alum of the formula K_2BeF_4, $Al_2(SO_4)_3$, $24H_2O$ has been reported.[24] The following tables give a comparative idea of the analogy between sulphates and fluoberyllates with respect to chemical formula and molecula volumes.

TABLE I.

Formula.	Mol. Vol. (30° C).	Formula.	Mol. Vol. (30° C).
$(NH_4)_2\ BeF_4$ $(NH_4)_2\ SO_4$	71·90 74·78	$Cs_2\ BeF_4$ $Cs_2\ SO_4$	83·23 85·23
$Li_2\ BeF_4.H_2O$ $Li_2\ SO_4.H_2O$	60·15 62·29	$Tl_2\ BeF_4$ $Tl_2\ SO_4$	74·23 75·60
$Li_2\ BeF_4$ $Li_2\ SO_4$	45·63 49·74	$Ba\ BeF_4$ $Ba\ SO_4$	53·32 54·92
$Rb_2\ BeF_4$ $Rb_2\ SO_4$	78·90 73·91	$Pb\ BeF_4$ $Pb\ SO_4$	47·63 48·64
$Ca\ BeF_4$ $Ca\ SO_4$ (anhydrite)	42·24 46·9	$Sr\ BeF_4$ $Sr\ SO_4$ (ppted.)	46·21 49·64

TABLE II.

FORMULA.		Remarks.
Fluoberyllates.	Sulphates.	
$Ni\ BeF_4 . 7\ H_2O$ ..	$Ni\ SO_4 . 7\ H_2O$	form mixed crystals.
$Ni\ BeF_4 . 6\ H_2O$ ..	$Ni\ SO_4 . 6\ H_2O$	,, ,, ,,
$Ni\ BeF_4 . 3\ H_2O$ ..	....	....
$Co\ BeF_4 . 7\ H_2O$ ..	$CO\ SO_4 . 7\ H_2O$	form mixed crystals.
$Co\ BeF_4 . 6\ H_2O$ ..	$CO\ SO_4 . 6\ H_2O$	,, ,, ,,
$Co\ BeF_4 . 3\ H_2O$ ..	....	....
$Co\ BeF_4 . 2\ H^2O$ ..	....	....
$Cd\ BeF_4 . 8/3\ H_2O$ ..	$Cd\ SO_4 . 8/3\ H_2O$	form mixed crystals
$Fe\ BeF_4 . 7\ H_2O$ ..	$Fe\ SO_4 . 7\ H_2O$	....
$Cu\ BeF_4 . 5\ H_2O$ ..	$Cu\ SO_4 . 5\ H_2O$	form mixed crystals.
$K_2\ Ni\ (SO_4 . BeF_4) . 6\ H_2O$	$K_2\ Ni\ (SO_4)_2 . 6\ H_2O$	....
$(NH_4)_2\ Zn\ (SO_4\ BeF_4) . 6H_2O.$	$(NH_4)_2\ Zn\ (SO_4)_2 . 6\ H_2O.$	....
$(NH_4)_2BeF_4\ .\ RBeF_4\ .\ 6\ H_2O.$	$(NH_4)_2\ SO_4 . RSO_4 . 6\ H_2O.$	where R = Ni, Co, Mg, Zn, Fe++, Cd or Cu. Possess approximately equal molecular volumes. NH_4+ in certain cases has been substituted by K+, Rb+, Cs+ and Tl+.

Monofluophosphate, PO_3F'', a bivalent complex ion, has been found to bear close analogy with SO_4'' ion.[25] As in the previous cases, these two complex ions are also isosteric and isoelectric, with closely similar ionic radii for their central and associated ions. Potassium monofluophosphate has been found to be isomorphous with potassium sulphate and they have approximately equal molecular volumes. Several other simple and double monofluophosphates as well as compounds of the alum type isomorphous with corresponding sulphates, have been prepared in our laboratory.[26] They are listed in the following table:—

1. $Cu\,PO_3F \cdot 5\,H_2O$.
2. $Ni\,PO_3F \cdot 7\,H_2O$.
3. $Co\,PO_3F \cdot 6\,H_2O$.
4. $Zn\,PO_3F \cdot 5\,H_2O$.
5. $(NH_4)_2\,PO_3F \cdot Al_2\,(PO_3F)_3 \cdot 24\,H_2O$.
6. $RSO_4 \cdot (NH_4)_2\,PO_3F \cdot 6\,H_2O$ } where R = Zn, Mn,
7. $(NH_4)_2\,PO_3F \cdot RPO_3F \cdot 6\,H_2O$ } Ni, Co, etc.

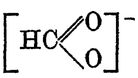
It has been further found that the double salt of ammonium fluoberyllate and nickel fluoberyllate forms mixed crystals, and grows uniformly in a saturated solution of the corresponding double salt of the monofluophosphate.

The stability of the three homologous complex ions varies in the decreasing order like

$$\overset{VI}{S}O_4'' \longrightarrow \overset{V}{P}O_3F'' \longrightarrow \overset{II}{Be}F_4'',$$

which as previously discussed, follows the same order as the magnitude of the charge on the central atoms of the complexes.

Another interesting case of isomorphism supported by mixed crystal formation is afforded by formates and nitrites.[27] The formate ion and the nitrite ion are usually represented by the following structures:



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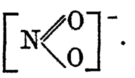

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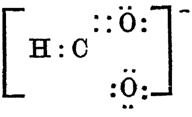

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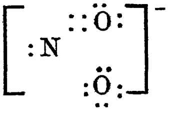

, they are isoelectric, and isosteric as well, with this difference that in the formates we have a CH group for the nitrogen atom of the nitrites. Now, as Grimm[28] has pointed out in his Hydrogen Displacement Law, that the group CH considered as a condensed nucleus, is equivalent to nitrogen atom in its behaviour. According to him, CH may be termed as a pseudo nitrogen atom. For, the sum of the nuclear charges of the CH group and the sum of the planetary electrons of its constituents are exactly equal to those of nitrogen atom, i.e. 7 in each case. Any difference that might exist in the radii of CH group and nitrogen atom is more or less compensated by the larger volumes of oxygen in the complex. There is therefore no wonder that under suitable conditions, nitrites and formates will crystallize together from solutions. It may be of interest to point out here that formic acid differs from its higher homologues acetic, propionic acids, etc., which can be accounted for on the basis of prototropy.[29]

Finally reference may be made to certain significant chemical analogy observed among positively charged complex ions. It is well known that tervalent chromium in its complex ammines simulates trivalent cobalt so completely in physical and chemical behaviour that it is difficult to distinguish between the two complexes without destroying the latter. The analogy in this case may be attributed to the identity of the charge of the complexes, equality in their ionic volumes and similarity in structure, though they are not isoelectronic. Assuming co-ordination bonds in these complexes, the 'effective atomic number'[30] (total number of planetary electrons shared or unshared) of cobalt in its complexes is 36, whereas that of chromium in similar compounds is 33 only. In most cases the colour of the corresponding complex salts are strikingly alike.

From what has been said above, it may be concluded that there are three essential factors determinative of chemical analogy. These are: (i) equality of the ionic charge or valency, (ii) similarity of structure, and (iii) approximate equality of ionic radii. Of these, the first is the most important and demands complete equality or identity both in magnitude as well as in sign; whereas the last two permit slight deviation within a narrow range. Analogy is perfect when the latter two are also very nearly equal, and then the substances become miscible in all proportions. Otherwise we come across with cases of partial miscibility.

Similarity in crystal forms, i.e. homeomorphy or isomorphism in its widest sense, may occur as already referred to, even when the valency of the individual constituents of the salts differ. But their ratio in each remains the same. This is illustrated by the following few examples[15]:

Salt.	Radii of constituent ions.			Salt.	Radii of constituent ions.		
Li F ..	0·76	1·33	..	MgO ..	0·76	1·32	..
$Li_2 BeF_4$ ..	0·78	0·34	1·33	$Zn_2 SiO_4$	0·83	0·39	1·32
Mg F_2 ..	0·78	1·33	..	TiO_2 ..	0·64	1·32	..
KMg F_3 ..	1·33	0·78	1·33	Sr TiO_3 ..	1·27	0·64	1·32

These substances are incapable of forming mixed crystals, hence are not chemically analogous though homeomorphous.

We thus find that following the method of analogy it has been possible to discover many new and interesting relationships between elements and radicles which could not be foreseen from a consideration of the Periodic Table alone, and it is hoped many more will be discovered in future. Development of this method has been possible by the formulation of the electronic structure of the atom, which gives us a clearer interpretation of its properties. The reproach that inorganic chemistry is merely a collection of uncoordinated facts without any connecting links or underlying principles which was often hurled at it before, no longer holds good, and it now presents no less fascinating a study than any other branch of our chemical science.

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SECTION OF GEOLOGY

President:—S. K. Roy, B.Sc., Ph.D., F.G.S.

Presidential Address

CONSERVATION OF INDIA'S MINERAL WEALTH

I. Introduction.

I thank you most heartily, fellow geologists, for the honour you have done me by electing me the President of your section this year. I extend to you all a most cordial welcome here today.

This section has been addressed by many eminent geologists before me, who by their discoveries, have made notable contributions to the development of the mineral industry of our country. I know my limitations for occupying this chair, and for that reason, I have selected a subject which is of general interest and at the same time of vital importance to our Nation.

The growth, greatness and survival of a nation depend largely on the natural resources of the country. The conservation of natural wealth such as agricultural products, forest products and minerals, like coal, iron, oil, etc., without which the very existence of a nation may be at stake, should, therefore, unquestionably be one of the most important matters for consideration of any Government. Conservation is the topic of the day. I have, therefore, selected the conservation of our mineral wealth as the subject matter of my address.

In the accompanying map, I have tried to give a rough idea of the distribution of the important minerals in India. The map is based on the publications of the Geological Survey of India and on the list of mines other than coal mines worked in British India, published by the Chief Inspector of Mines in India. Further details about the map are given in the Appendix I. Though at the first glance the mineral resources of our country may seem from this map to be abundant, but considering the vast size of India, the occurrences are few and far between, and the value of many of these deposits being not properly known, it is not easy in their present state for a capitalist to consider whether it may be worth while to invest his money in them. As it is not generally realized that India's resources of some of the very important minerals, like coal, petroleum and others, are limited, conservation of their diminishing supply has become urgently necessary.

With the advancement of civilization the use of metals has increased in a tremendous manner. During the approximately 100 years that have lapsed between Waterloo and Marne, the metal consumption of the world has increased by about 100 fold. In the last 25 years, the world has used more metal and more fuel than in the entire historical time. The geometric increase in the consumption of minerals that took place during this time is almost incredible. Minerals are the most important sources of raw materials for many chemical industries. Even modern warfare is dependent on metals, nitrates, petroleum and coal-tar derivatives.[1] Conservation of minerals, therefore, is at present one of the most vital issues confronting many important countries of the world for their future growth and prosperity.

In discussing the meaning of conservation, Franklin K. Lane [2] said:—

> "The word should mean helpfulness, not hindrance—helpfulness to all who wish to use a resource and think in larger terms than that of the greatest immediate profit; hindrance only to those who are spendthrift. A conservation which results in a stalemate as between the forces of progress and governmental inertia is criminal, while a conservation that is based on the fuller, the more essential, use of resources is statesmanship.
>
> "To know what we have and what we can do with it—and what we should not do with it, also is a policy of wisdom, a policy of lasting progress. And in furtherance of such a policy the first step is to know our resources—our national wealth in things and in their possibilities; the second step is to know their availability for immediate use; the third step is to guard them against waste, either through ignorance or wantonness; and the fourth step is to prolong their life by invention and discovery."

There is no comprehensive book dealing with the economic aspects of Indian minerals, written in a popular manner suitable for the mass of a country where 94% of the population cannot still read English. There is no organized attempt anywhere in India to teach our countrymen about mineral economics, though mineral economics, in recent years, has generally attained such dimensions that there are people who are devoting their whole time to the study of one particular branch of mineral economics. Thus, we have petroleum specialists, copper specialists, mica specialists, coal specialists, and others.

What our mineral resources are and what we can do and what we should not do with our minerals are subjects which every mineowner should know. The existing literature on the Indian minerals are utterly inadequate to meet the need. Sometimes they are too technical for the mass. Except for coal, we do not possess even the barest knowledge about the reserve and resources of other minerals; and excepting in the coal mines, there is no restriction on the qualification of the manager of mines. In many cases, such mine managers are illiterate small capitalists who scarcely pay any heed to conservation and are out to get money by "raubbau" methods only. There is no institution in India to tell the mineowner that "private ownership is in reality public trust and that the owner's right to do as he pleases even to squander natural resources, cannot and will not be tolerated indefinitely by society"[3]. Last of all, new discoveries of mineral deposits are rare, and in recent years this has suffered a terrible set-back by a serious curtailment in the already understaffed Geological Survey of India, one of the main objects of which is the discovery of mineral deposits.

In the second part of my address, I have tried to make out a case for the revival of some of the forgotten minerals, the mining of which has now-a-days become more or less a matter of the past. India once took the leading part in the production of diamond; and though till the middle of the last century India supplied 98% of the world's output ("Story of the Gems" by Herbert P. Whitlock), diamond mining has now become almost extinct in India.

II. CONSERVATION OF FUEL MINERALS.

(*a*) *Coal*: A good deal has been written in recent years on the conservation of coal[4–10], outside the Geological Survey of India. Public attention has been drawn to the coal industry mostly on account of the serious mining accidents which have occurred one after another during the last few years, and on account of the huge fires that are consuming millions and millions of tons of our best coal in the most important coal-fields of our country. A Committee has, therefore, been set up to investigate the various sources of danger to coal mining. Dangers due to fire, irregular working of thick seams, the occurrence of coal dust and gas in mines, and those due to pillar robbing, inaccurate surveying, etc. have been adequately discussed by the Coal Mining Committee, 1937, and their remedies have been suggested. The whole survey of the Committee has been boiled down to the fact that measures which increase safety also improve conservation, and that measures which make for conservation also make for greater safety. The most satisfactory method of conservation of coal and consequent safety in working has been found to be hydraulic packing, locally known as sand-stowing. Nothing but a complete stowing by sand is likely to be really effective as a safety measure, and thus conserve one of our key industries, namely coal mining industry. We do hope that the

Government will find it possible to put the recommendations of the Committee, especially those dealing with sand-stowing, into effect and thus earn the gratitude of the country.

With sand-stowing enforced by law, the most important problem of safety in mines is more or less solved. The next most important point regarding Conservation of Coal is to find out new uses of coal whereby the greatest efficiency and consequently economy may be obtained from the mineral. This can be achieved by a thorough re-survey of the coal fields and by intensive fuel research. Due to the recent publications by the Geological Survey of India, we possess now-a-days excellent accounts of some of our coal fields. Geological prospecting work carried out recently by my colleagues, students [11–23] and myself in the two most important coal fields of Raniganj and Jharia, has made further addition to our knowledge of these two coal fields which are responsible for about 95% of the total coal mined in India. "The chemical composition of the Indian coals has been investigated by Bhattacharjee and Mahadevan while the action of solvents on coal has been studied by Datta Roy" [24]. Further chemical investigations on Indian coals have been carried out by Forrester [25], Majumdar [25a] and Chatterjee [26–27] as well as by Ghosh and Sen [28]. Cleaning of Indian coals has been carried out, amongst others, by Randall [29] who applied froth flotation process for this purpose.

One of the purposes for which the Coal Mining Committee was set up was to investigate the possibility of carrying out fuel researches in our country. The Government of India in their letter, No. M955 of 17th June, 1936, addressed to local Governments, expressed the desirability of researches into the better utilization of coal. This was considered in para. 15 as one of the main issues on which opinion and information were required. (J. Thomas, Editorial Notes, Trans. Min. Geol. Inst. India, Vol. 33, p. 240.) But unfortunately the recommendations of the Coal Mining Committee have been so worded as to indicate that researches on safety in mines are of greater importance than fuel research. It has been pointed out by the Committee over and over again that most of the disastrous consequences of careless mining, as was in vogue in our country until recently, would be remedied by complete stowing of the mines with sand. The increase of safety so brought about by sand-stowing, will increase conservation. Sand-stowing is, therefore, going to serve all the necessary purposes for safety in mines, and, therefore, in my opinion, researches on safety in mines should not be given preference over fuel research, as the latter is at present of equally great and vital importance to our country's future. Let us for the time being remain content with sand-stowing measures alone for the safety in coal mines. If it does not satisfy our purpose, we may then think of further measures regarding safety, and to that end, researches on safety in coal mines might be carried out at a later stage. But what is of immediate interest to our country is Fuel Research.

Our reserve of metallurgical coal (if the present unrestricted and unnationalized consumption continues without adequate State control) is going to be frittered away in course of another decade or so. On the other hand, the reserve of high ash II class coal is fairly large. At present it is being sold mostly in the form of soft coke. Every year we manufacture about 1 million tons of soft coke in the Jharia Coal field. Usually it is estimated that 3 tons of coal when burnt make 2 tons of soft coke.* Thus during the manufacture of 1 million tons of soft coke, half a million tons of valuable coal by-products are being burnt away. Researches on the soft coke making coals of the Jharia Coal field carried out jointly by my friends, Prof. B. C. Roy, Prof. S. K. Bose, Mr. S. S. Ghosh and myself, have shown that every ton of these II class coals of Nos. IX, X, XI and XII seams of the Jharia field at the time of making soft coke, gives out, among others, on an average about 10 gallons of tar. At present this is wholesale wasted. Thus, from the 1·5 million tons of coal treated annually for making soft coke, about 15 million gallons of tar containing valuable by-products, e.g. motor spirit, diesel oil, kerosene, lubricating oil, ammonia, carbolic acid and creosote oil, besides hundreds of millions of cu. ft. of gas of good calorific value as well as an enormous quantity of road-tar are wasted in our country every year.

Following are the nature of the by-products of soft coke as determined by us:—

Coal Sample No. 1 ; *No.* XII *seam.*

Proximate analysis.

Moisture	0·766%
Volatile matter ..	23·384%
Fixed Carbon	56·45%
Ash	19·40%

Distillation test.

Amount of coal distilled ..	50 gms.
Fineness of grains of coal ..	10 to 20 I.M.M.
Temperature of the furnace ..	550° to 560°C.

---

* Our experiments, however, show that the average yield of soft coke per ton of coal is about 17 cwt.

Products of distillation:—

Coke (high swelling, and hard)	39·25 gms. @ 15·7 cwt./ton coal.
Tar (tar oils measured under moist condition)	2·5 c.c. @ 11·2 gals./ton coal.
Gas	4 litres @ 2,880 cu.ft./ton coal.
Amm. Sulphate	7·5 lbs. per ton of coal.

Coal Sample No. 2; *No.* XI *seam.*

Proximate analysis.

Moisture	0·83%
Volatile matter	22·20%
Fixed Carbon	61·43%
Ash	15·563%

Distillation test.

Amount of coal distilled	100 gms.
Fineness of grains of coal	10 to 21 I.M.M.
Temperature of the furnace	560° to 565°C.

Products of distillation:—

Coke (moderately swelling)	81·1 gms. @ 16·2 cwt./ton coal.
Tar (Tar oils measured under moist condition)	6·5 c.c. @ 14·56 gals./ton coal.
Gas	11·75 litres @ 4,230 cu.ft./ton coal.
Amm. Sulphate	2·5 lbs. per ton of coal.

Coal Sample No. 6; *No.* X *seam, Jharia Coal Field.*

Proximate Analysis.

Moisture	0·981%
Volatiles	21·66%
Fixed Carbon	61·48%
Ash	15·9%

Distillation test.

Amount of coal distilled ..	10 lbs.
Temperature of the furnace ..	550° to 575°C.

Products:—

Coke	81 lbs. 8·5 ozs. @ 17 cwts. per ton.
Tar oil ..	150 c.c. @ 7·5 gals. per ton.
Gas	4,600 cu.ft. per ton.
Calorific value ..	770 B.T.U. (I) (÷1·8 will give calories per gram).
	744·7 „ (II).
	722·8 „ (III).

Coal Sample No. 7; *No.* X *seam*; *Jharia Coal Field.*

Proximate analysis.

Moisture	1·03%
Volatiles	20·63%
Fixed Carbon	60·75%
Ash	17·55%

Distillation test.

Amount of coal distilled ..	10 lbs.
Temperature of the furnace ..	550° to 575°C.

Products:—

Coke	8 lbs. 8 ozs. @ 17 cwts. per ton.
Tar oil ..	150 c.c. @ 7·5 gals. per ton.
Gas	4,600 cu.ft. per ton.
Calorific value of gas	747·3 B.U.T. (I).
	725·1 „ (II).
	730·3 „ (III).

Fractional distillation of the tar obtained from a ton of No. X seam coal, the greatest favourite for soft coke making in Jharia Coal field, gives the following result:—

Temperature of the furnace: 550° to 575°C.

(Tar oil (moist) ..	7·5 gallons per ton.)	
Up to 90°C. ..	0·112 litres	Motor spirit.
90°–130°C. ..	2·352 litres	
130°–150°C. ..	2·85 litres	Light oil. Kerosene.
150°–210°C. ..	1·8 litres	
210°–350°C. ..	8·3 litres.	Fuel oil.
Phenols ..	2·25 litres (Carbolic acid and Creosote oil).	
Residual Pitch ..	19·7 lbs.	

Gas	4,600 cu.ft., Cal. value of approx. 750 B.T.U.
Ammonium Sulphate ..	14 lbs.

If for some reason or other the maritime route to India were interfered with, there is bound to be a great dislocation of communication and industry for want of liquid fuel, the home supply of which is very inadequate (see p. 11). It is, therefore, of fundamental importance to our country not only from the standpoint of conservation of coal but also from the vital interest of transport, to carry out researches on our coals in order to find out ways and means to economically save these millions of gallons of tar and hundreds of millions of cu.ft. of gas which are now-a-days being wasted.

The approximate figures for the various by-products of tar which are at present being wasted during the annual soft coke making, from the Jharia coals is as follows:—

0·75 million gallons of Motor Spirit (Benzine).
1·50 ,, ,, Light oil (Kerosene).
3·00 ,, ,, Fuel and lubricating oils.
0·75 ,, ,, Carbolic acid and Creosote oil.
10,500 tons of Ammonium Sulphate.
15,000 tons Residual Pitch; and about 7·5 Billion cu.ft. of very rich gas, capable of generating about 25 million Horse power.

We, therefore, have thought that researches in this direction may be extremely useful for the coal industry immediately. Hence, jointly with my friends, Prof. B. C. Roy, Prof. S. K. Bose and Mr. S. S. Ghosh, I have already started work on the following lines:—

No. I.—Low temperature carbonization products of the poorer grade coals of Jharia, that is, fuel gas, benzine, light oil, heavy oil, ammonia, naphthol, phenol and tar contents of the coals of No. VII, VIII, IX, X, XI and XVI seams of the Jharia Coal field.
No. II.—Fusibility of the ashes of the poorer grade coals.
No. III.—Improvement in the soft coke making properties of certain coals which make unsatisfactory soft coke at present.

All these researches are expected to help conservation of our Metallurgical Coal. The expected benefits of each one of the above researches to the Coal Industry are enumerated as follows:—

No. I: The existing coke ovens, owned by the Government and big industrialists, utilize superior grade coals for making coke and many of them also recover the by-products by this high temperature process. So we already possess, thanks to the well-equipped coke ovens at Giridih, Bararee, Jamshedpur, Burnpur, Kulti, etc., substantial knowledge of the gas and tar, of the superior class coal of the Jharia Coal field which is now mostly used, of course, as fuel. But nothing so far is known about the gas and tar-producing capacities of the immense quantity of II class coal used in the Jharia Coal field for making soft coke, nor do we know anything about the composition of the gas and tar they produce, although in the manufacture of soft coke about one-third of the coal is lost in the form of gas and tar. Taking the most conservative estimate of about two million tons of soft coke being annually manufactured in the Jharia Coal field, leaving aside its gas for the present, and putting its tar content at the moderate figure of 10 gallons per ton of coal used, about 30 million gallons of tar, comparatively rich in motor spirit, light oils and other substances are lost to our country. It is, for this reason that we propose to undertake firstly a series of researches on the gas and tar contents of the poorer grade coals used for soft coke making in the Jharia Coal field and subsequently to find out what are the by-products of this tar.

The making of soft coke does not involve high temperature. The usual temperature of soft coke 'bhattas' is about 300°C to 500°C. We believe that ovens made of ordinary fireclay bricks would stand this temperature. After the gas and tar contents as well as the by-products of the poorer grade coals used for soft coke making have been determined in the laboratory, it is necessary to investigate the possibility of easy extraction of tar by means of such brick-built ovens at a suitable place in the Jharia Coal field from the coal which from our analyses we have known to be best suited for this purpose. This is likely to improve the economic value of our II class coals which are not favoured for steam raising, though many of them are quite suited for that purpose.

No. II: Many of our inferior grade coals, now supposed to be unsatisfactory for steam raising, can become quite good for locomotive firing and steam raising in general, if made into pulverized fuel. But such powdered coal must not fuse on the grates. In that case it will choke the air supply. The fused matter will also form a coating round the still unburnt particles of coal and will not let them burn. Thus the heat-raising quality of the coal will suffer if the powder melts on the grate. Nothing is so far known about the fusibility of the ashes of our lower grade coal. It is necessary to see which of the coals now used for soft coke making do fuse and which of them do not.

A knowledge of the gas contents of these coals and the amount of moisture present in them are very necessary for determining the heating property of these coals. The researches proposed in No. I will give us an idea about the gas content of the coal but would not tell us anything about its fusibility. Therefore, a second series of researches are necessary. As a result of these researches, we may be able to hit at certain so-called II grade and III grade coals which do not fuse easily and, therefore, are quite good for steam raising purposes. Such II and III grade coals quite suitable for all sorts of steam raising purposes are expected to replace some of our Selected and I grade coals and help conserve metallurgical coals.

No. III : There are certain II class coals in the Jharia Coal field (e.g. Seam No. IX Godhur, and VII Tisra) which have at present no good demand on account of their ash percentages being high, and they are not accepted by the railways and metallurgical plants. Secondly, because they do not make good, that is light, swelling, soft coke, they are not so much in favour with the coal merchants. If we can find out some means to make these coals swell when heated they will immediately have better prospects. That these coals might make better soft coke by mixing with some high-class coking coal is already known. Our object is to investigate and, if possible, to find out some sort of a catalyser which will increase the swelling properties of these coals, will make a somewhat lighter soft coke out of them, and thus make them marketable. Molasses and common salt are being tried for the purpose. This may decrease to some extent the sale of the better type of II class coal, namely, those of seams No. IX, X, XI and XII, and release them for the use of railways, while the coal of superior quality, that of XIII, XIV, XV, XVII and XVIII seams, may be preserved for metallurgical purposes.

(*b*) *Petroleum*: We have already dealt with the conservation of coal. But coal is not the only natural fuel available in our country which is found in a limited quantity, and on whose production and working there does not exist up till now any State control. The other important natural fuel existing in our country is Petroleum.

We live now in an age of petrol. The motor car that brought us here, the aeroplane that carries letters from India to England within such a short time as three days, a winged speed unimaginable by our forefathers; the submarine, the most dreaded of all the fighting vessels of the sea, the Zeppelin, the oil engine, the bus, the lorry, are all run by petroleum and its products. But for petroleum lubricants, we could never have had the present rapid growth of any form of swift locomotion, either by steam, gas, or electricity. Modern warfare is mostly dependent on petrol and petroleum products. Petroleum and its products form the basis of many medicines and cosmetics. But usually it is not realized that Indian resources for petroleum from which kerosene, diesel oil, lubricating oil, vaseline, grease and paraffin wax are derived, are exceedingly limited.

India's total consumption of petroleum and its products is about 400 million gallons. Following are the figures for the year 1937:—

Articles.	*Quantity.*	*Value.*
	Galls.	Rs.
Petroleum, dangerous, flashing below 76°F, including petrol, benzine and bensol	87,784,464	4,48,78,512
Kerosene oil	162,850,131	6,00,73,832
Lubricating oils—		
(i) Batching oils	15,708,925	42,20,658
(ii) Other lubricating oils ..	17,912,427	1,68,84,925
Fuel oils	127,809,056	1,84,47,938
Paraffin wax	tons 1,377	3,83,573

(From 1st April, 1937, the figures include the trade of British India with Burma but exclude the direct foreign trade of Burma. The details have been very kindly supplied by the Director-General of Commercial Intelligence.)

Of this required amount of 400 million gallons, only about 76 million gallons of oil is produced in India—about 65 million gallons in Assam and the rest in the Punjab. Following are the details of quantities produced in India: (vide Director-General of Commercial Intelligence's letter dated 24. 9. 38):—

Crude Petroleum ..	75,657,857 gallons.
Natural gas and gasolene ..	456,780 ,,
Total about	76 million galls.

A careful look at the tables given above will show how deficient India is in these products. Petroleum, the natural product from which all the above articles are derived is, so far, found only in the provinces of Assam and the Punjab. The supply of petroleum from Assam and the Punjab wells is very limited.

The oil industry is new. First oil well was drilled in America about 80 years ago (1859) by Col. E. L. Drake near Titasville, Pennsylvania, and since then the oil industry has progressed steadily. The method as developed in working oil has always aimed at avoiding waste, i.e. the object is to obtain the greatest possible amount of oil and gas from the natural deposits. I wish to point out here the various possible types of oil and gas wastes. How they are to be remedied is not intended to be discussed in this address. I may mention, however, that their remedies are available, and I believe that the companies now developing the Oil Fields of our country are taking the necessary precautions. To meet the country's demand for conservation, however, I would suggest emphatically that Government should take more interest in the oil resources of our country by appointing a representative who should be fully qualified for the work and who may be an officer of the Geological Survey of India, specially trained in petroleum geology. In countries like U.S.A., with a well-developed petroleum industry, the Government do actually employ petroleum technologists to look after the public interests regarding conservation and economic working of the resources of the oil wells. The man who does the work is called a Supervisor. The definition of a supervisor is 'The agent appointed by and with the power to act for the Secretary of the Interior in supervising all operations for the discovery, production and computation of royalties for oil and gas'[30]. There is no reason why the petroleum fields of India should not be controlled by such supervisors.

Petroleum occurs in subterranean vaults called 'domes' consisting of various petroleum-bearing layers, the depths of which may vary from several hundred feet to more than a mile as is the case in the Punjab. It is quite common to find in such vaults situated at great depths several petroleum layers one above the other separated by water-bearing layers. This has been explained in Fig. 1.

The waste of oil due to water is of the most extensive nature. Entire oil and gas fields are known to have been damaged by flooding. Underground water inundating an oil horizon causes loss of gas and natural gas—gasoline. Water increases lifting costs of oil to such an extent that many wells have had to be abandoned for reasons of expenses. Some underground water is so corrosive that it affects the pipe line, the pump, the sucker rods and other equipment to such an extent that pumping of oil mixed with such water becomes almost impossible. Further, water emulsifies oil; it is very expensive to separate oil from such emulsion.

In an oil field water may occur above or below the oil sands (see Fig. 1). Top water is the name given to water in a stratum occurring above the main oil-producing stratum, and bottom water occurs in a bed below the oil-producing stratum. They are both separated from the oil stratum by means of impervious layers. The top water is usually the greatest source of trouble in oil fields.

If the bottom water is under pressure it may flood the top oil zone as readily as a bottom oil horizon. Underground water has been known to be the cause of the premature abandonment of many producing oil sands.[31, 32] Figure 2 gives an idea as to how a gas sand can be flooded by bottom water on account of careless cementation.

It is not difficult to determine the position of various water-bearing layers in an oil well. It can be done from a careful study of the records of the well producing water and neighbouring wells and from a careful geological study of the field. The position of water in a bore hole can also be determined by analysis

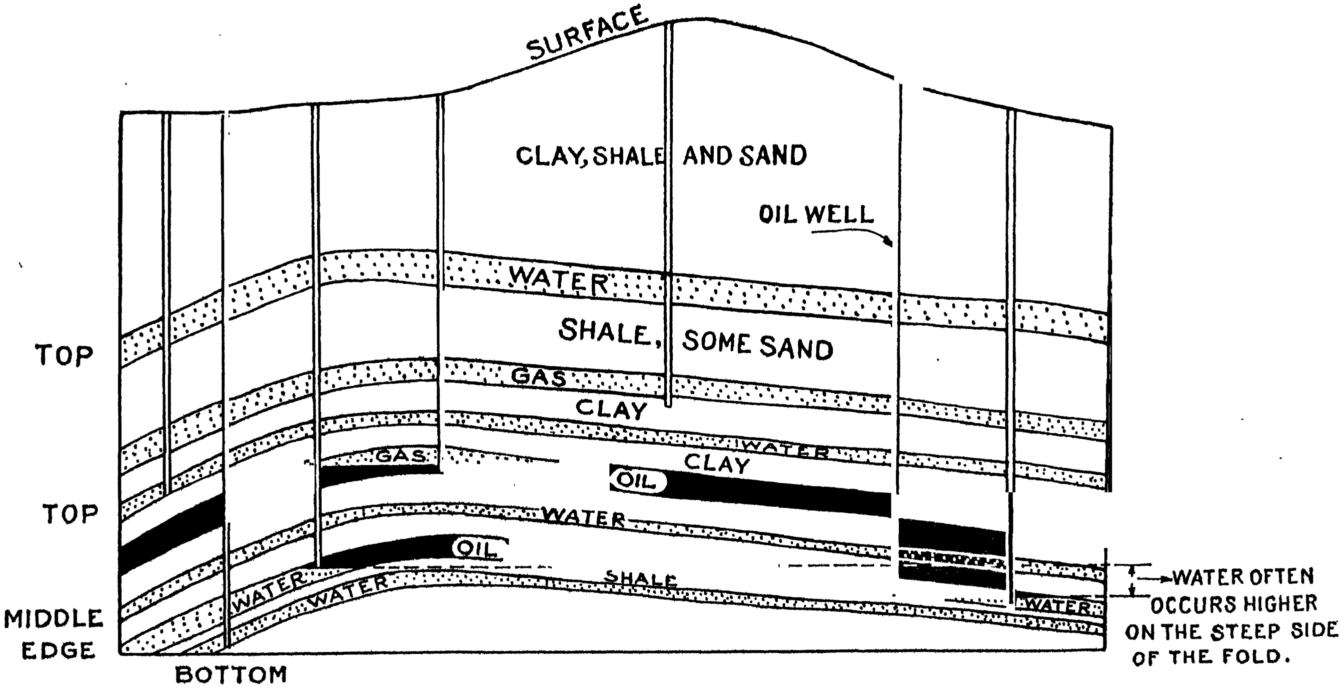

Fig. 1. Hypothetical sketch to show different water sands. (*Swigart and Beecher.*)

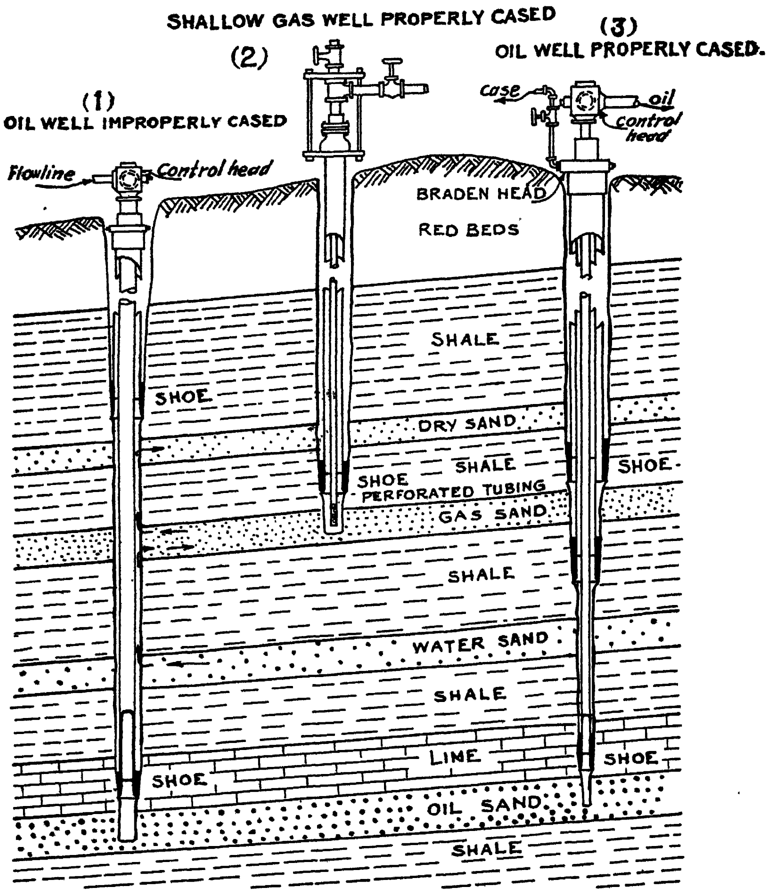

FIG. 2. Example of Unsystematic Casing and Improper Protection of upper gas sand. (*Swigart and Beecher.*)

of the water coming out by the bore hole and by using dyes such as fluorescine, eosine, methylene blue, venetian red and acid of orange.

Various methods have been suggested for excluding water from oil and gas sands. As I have stated above, it is not my object to deal with these methods in detail here; I just mention them at this place for ready reference.

They are:—

(1) A formation shut off method.
(2) Casing and tubing packer method.
(3) Cementation method. By means of pumping, baling or tubing, casing, etc., according to convenience.

(4) Plug method.
(5) Halliburton method.
(6) Mud fluid method.
(7) Plugging by means of lead wool, etc.

The other cause of loss of oil in an oil field may be due to the failure to confine an upper productive sand. Many oil wells are drilled through soft oil and gas-bearing formations before they reach the sand from which it is desired to obtain the production. Very often these upper sands in places contain considerable quantities of oil and gas under pressure. In a rotary tool drill with a hole full of mud, such sands may be overlooked. Sometimes loss of petroleum and gas due to this is considerable. According to the mineral concession manual, the provincial Government is expected to receive a royalty of 5% with natural gas, even if utilized by the company. In U.S.A. the royalty is 12½ to 16⅔% of the value thereof in the field where produced*[33]. As it is a source of revenue to the provincial exchequer, any loss of gas in the oil field requires to be remedied. Further the gas moving up or down the bore hole, may ultimately creep into some porous layer and escape on the surface. In this way, sometimes, this gas gives false oil shows and becomes the cause of a good deal of loss to the prospector. Careless casing and imperfect water shut off have caused great underground waste of gas and oil. The new method of protecting upper sand is to seal off the formations with mud fluid or cement, a second method is to land casing above and below the producing strata. The cementing method used in the case of shutting up of water is possibly more common. This is also probably cheaper.

Spacing of oil wells is another very important point in which there should be Government control. Speaking theoretically, the closer the spacing of oil wells, the greater is the ultimate recovery of oil from oil sands. Therefore, it should always be the policy of the Government to encourage such close spacing that the maximum amount of royalty may be recovered from oil. There are, however, many factors which control the distance of spacing, but the most efficient one can always be calculated by the Government geologists. If spacing is carried on in a rectangular system, the usual spacing is about 4 acres per well.

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* Royalty on gas is computed in U.S.A. in the following way:—

Assume:

That the price the lessee receives for natural-gas gasoline is 18 cents per gallon.

That 3 gallons of gasoline are recovered from each 1,000 cubic feet of natural gas treated.

Then:

The value of the gasoline on which the Government takes its royalty is equal to one-third of 3 gallons (per 1,000 cubic feet of gas), or 1 gallon, having a value of 18 cents. The Government's royalty on gasoline in this case is:

⅙ (= 16⅔ per cent) × 1 (gal.) × 18 cents = 3 cents (on each 1,000 cubic feet of natural gas treated).

The next point which requires Government control, as Government is the lessor of all oil in our country, is the control of losses from flowing wells. Apart from the loss from gushers, or wild wells, considerable oil and gas can be lost while the well is being completed.* All other flow of oil is controllable, but when tubing is being run, the casing head remains open and if the oil well is not properly controlled, there is always a chance of considerable loss of oil and gas through the casing head. During the days of Spindle top (1901-02), some of the enormous gushers of the Texas Oilfield were sometimes turned in the air just for the amusement of sightseers. Now-a-days, of course, such waste is considered criminal.

In the case of some of the wild wells, the pressure is known to be so great and the flow so constant that when the gate valves were torn open from the casing head, flow of several thousand barrels of oil per day was wasted, and a tremendous flow of gas wrecked the derrick. Modern gas well and drilling methods have reduced the loss due to wild wells to a minimum [34-38].

Increase of oil production by torpedoing.—Often the production from a well situated in hard tight sands may reach the maximum rate by torpedoing the borehole. This 'torpedoing' or 'shooting' of the borehole is necessary in many fields to obtain the maximum production but sometimes it may also ruin the well. 'Shooting' may also damage the casing, ruin casing sheets, and sometimes it may also shoot into the water. Usually such 'shooting' is done with the field force of the Company, but at times this is necessary to increase production and also to overcome certain difficulties in drilling. Shooting, however, as stated above, requires very great experience and skill, and a misplaced shot or too heavy a shot may easily ruin a borehole, but as there is the direct connection also with the pipe, it has sometimes got to be done and must be done.

Swabbing.—Very often during the completion of an oil well, swabbing a well is necessary, but vigorous swabbing endangers water shut off and brings about various other difficulties. Thus it may cause considerable underground loss of oil and gas.

What amount of State control is necessary on the field operations of petroleum may be apparent from above. How this control is in operation in U.S.A., the greatest producer of oil, can be understood from the following duties of the Government Oil Supervisors and requirements for lessees [39].

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* But fortunately, as far as my personal knowledge and enquiries go, I am able to say that every precaution is taken by the existing oil companies in India to prevent such losses.

Section 1. *Powers and Duties of Supervisor and his Deputies.*

It shall be the duty of the supervisor and his deputies:—

(*a*) To visit from time to time leased lands where operations for the discovery or production of oil and gas are conducted, to inspect and supervise such operations with a view to preventing waste of oil and gas, damage to formations or deposits containing oil, gas, or water, or to coal measures or other mineral deposits, injury to life or property, or economic waste; and to issue, in accordance with the provisions of the lease and these regulations, such necessary instructions to lessees as will effectively prevent waste or damage to deposits containing oil, gas, water, or other minerals, or injury to life or property.

(*b*) To make reports to the Secretary of the Interior as to the general condition of the leased property and the manner in which operations are being conducted and the Secretary's orders are being complied with, and to submit from time to time information and recommendations for safeguarding and protecting the surface property and the underlying mineral-bearing formations.

(*c*) To prescribe, subject to the approval of the Secretary of the Interior, the manner and form in which all records of operations, reports, and notices shall be made.

(*d*) To require that tests shall be made to detect wastes of oil and gas, as well as the presence of oil, gas, or water in a well and to prescribe or approve the methods of making such tests.

(*e*) To require the correction, in a manner to be prescribed or approved by him, of any condition existing subsequent to the completion of a well which is causing or is likely to cause damage to any formation bearing oil, gas, or water, or to coal measures or other mineral deposits or which is dangerous to life or property or wasteful of oil or gas.

(*f*) To determine the percentage of the potential capacity of any gas well which may be utilized when, in his opinion, such action is necessary to properly protect the gas-producing formations. The deputy or his representative likewise will specify the time and method for determining the potential capacity of gas wells.

(*g*) To assist and advise with Government lessees, making tests and carrying on experiments for the purpose of increasing the efficiency of operations.

(*h*) To sign receipts for any and all royalty oil delivered to the Government account and to designate a representative to sign provisional receipts for royalty oil.

(*i*) To sign division orders granting pipe-line companies authority to receive oil or gas from Government lands in accordance with Government rules and regulations.

Section 2. *Requirements for lessees.*

(*a*) The lessee shall conform to the terms of the lease and regulations and to the written instructions of the supervisor or his deputies and shall take precautions to prevent waste of oil or gas, damage to formations or deposits bearing oil, gas, or water, or to coal measures or other mineral deposits, injury to life or property or economic waste.

(*b*) The lessee shall designate in writing a local or resident representative for each permit or lease or for each group of permits or leases he holds and shall give the local post-office address of such resident representative on whom the supervisor or other authorized representative of the department of the Interior may serve notice or with whom he may otherwise communicate in securing compliance with these regulations. The resident representative of the lessee of lands not yet drilled shall be designated before drilling or other operations are begun.

If said designated local or resident representative shall at any time be incapacitated for duty or absent from his residence as given in the report furnished, the lessee shall designate in writing some person to serve in his stead, and in the absence of such representative or of written notice of the appointment of a substitute, any employee of the lessee who is on the leased premises, or the contractor or other person in charge of operations, shall be considered the representative of the lessee for the service of orders or notices as herein provided and service upon any such employee, contractor, or other person shall be deemed service upon the lessee. All changes of address of the designated representative shall be immediately reported, in writing, to the local deputy or his representative.

(*c*) The lessee shall not drill any well closer than 200 feet from any of the outer boundaries of the land covered by a permit or lease except as closer spacing may be necessary to protect against offset wells on lands the title to which is not held by the United States of America.

(*d*) The lessee shall not begin to drill, redrill, deepen, shoot, plug or abandon any well or alter the casing in it without first notifying the deputy supervisor or his representative of his plan or intention and receiving approval of the contemplated work.

(*e*) The lessee shall permanently mark all rigs or wells in a conspicuous place with his name or the name of the actual operator and the number or designation of the well and shall take all necessary means and precautions to preserve these markings.

(*f*) The lessee shall keep on the leased premises or at his headquarters in the field accurate records of the drilling, redrilling, deepening, plugging, or abandoning of all wells and of all alterations to casing, the records to show all the formations drilled through and their content of oil, gas or water (and if water, its character), if any, and the kinds, weights, length, and sizes of casings used in drilling the wells and copies of such records shall be transmitted to the local deputy supervisor or his representative by the lessee on prescribed forms furnished by the Bureau of Mines within 15 days after the first completion of any well or after the completion of any further operations on it. The lessee shall also submit to the deputy supervisor such other reports and records of operations as may be required, in the manner and form prescribed by the deputy supervisor.

(*g*) In drilling in " wild cat " territory, or in a gas or oil field where high pressures are likely to exist, the lessee shall take all proper precautions necessary for bringing the well under control at any time and shall provide at the time the well is started the proper high-pressure fittings, etc. required for such work.

(*h*) When drilling with cable tools the lessee shall provide at least one properly prepared slush pit, into which he must deposit mud and cuttings from clays or shales which will be suitable for the mudding of a well, except when drilling in a proven area where it is known that such precautions are unnecessary. When occasion demands, a second pit must be provided for sand pumpings and other material extracted from the well during the process of drilling but not suitable for mudding.

(*i*) When drilling with rotary tools, the operator will provide when required by the deputy supervisor or his representative an auxiliary mud pit of suitable capacity in which he can maintain a supply of extra heavy mud for emergency use in cases of blow-outs or lost circulation. When occasion demands, surplus mud and cuttings shall be confined in suitable pits.

(*j*) The lessee will be required to effectually shut off and exclude all water from any oil or gas bearing stratum by a method approved by the deputy supervisor or his representative. Moreover, the lessee shall test each water shut-off before completing the well and drilling into the oil or gas sand, by a method approved by the local deputy.

(*k*) The lessee shall not deepen an oil gas well for the purpose of producing oil or gas from a deeper stratum unless the upper producing strata are properly protected. No producing oil or gas well shall be abandoned except in a manner approved by the deputy supervisor and only where it can be demonstrated that the further operation of such well is commercially unprofitable.

(*l*) The lessee shall prevent any oil or gas well from blowing open and shall take immediate steps and exercise due diligence to bring under control any "wild" or burning oil or gas well.

(*m*) The lessee shall operate his wells in such manner as to eliminate, in so far as possible, the formation of emulsion or so-called B.S. If the formation of emulsion, or B.S., cannot be avoided and the oil cannot be recovered from the emulsion by usual methods of treatment, the lessee shall treat the oil to put it into a marketable condition if it can be recovered at a profit. The deputy supervisor is empowered to authorize the deduction, before the royalty is computed, of the cost of putting the oil into marketable condition by such unusual methods in order to encourage the conservation of oil. To avoid excessive evaporation losses or "burning the oil", the lessee shall not heat emulsified oil for the purpose of breaking down emulsions to temperatures above the minimum temperature required to put the oil into marketable condition.

(*n*) B.S. and salt water from tanks or wells shall not be allowed to pollute streams or damage the surface of adjoining lands. In cases where the B.S. cannot be treated or burned and the volume of salt water is too great for disposal by seepage and evaporation, the lessee should consult with the deputy supervisor regarding its disposal and dispose of it under some approved method.

(*o*) All oil run from Government leases or permits shall be gaged according to methods approved by the supervisor or his representative. The lessee shall provide tanks suitable for containing and accurately measuring the crude oil produced from the wells, and shall furnish to the deputy supervisor at least two accurate copies of all tank tables. The lessee shall not, except during an emergency, and by special permission of the deputy supervisor, permit oil to be stored or retained in earthen reservoirs or in any other receptacles in which there may be undue waste of oil by seepage or evaporation.

(*p*) Before plugging or abandoning a well the lessee shall submit to the deputy supervisor or his representative the detailed plans for carrying on the work, together with duplicate copies of the log in case it has not already been submitted, and proceed with the plugging or abandonment only on receiving the approval of the deputy supervisor.

(*q*) The lessee shall prevent the waste of natural gas or its wasteful utilization. The use of gas in its natural state in engines, pumps, or similar equipment where its pressure is the direct operating force is prohibited unless the exhaust gas is conserved for use as fuel or unless special permission is obtained from the supervisor or his representative. Other conditions or methods which, in the opinion of the supervisor or his representatives, are wasteful of natural gas but are not specifically mentioned will not be permitted.

(*r*) The lessee shall exercise reasonable precaution in providing against accidents and fires and shall make a full report to the deputy supervisor of all accidents or fires on the leased premises.

(*s*) In matters pertaining to the operations of oil and gas properties, not specifically mentioned in the foregoing regulations, the supervisor or his representative shall have power to require of lessees compliance with such orders as may be necessary to effect the greatest saving of oil or gas. Subjects of controversy shall be settled in conference between the lessee and the supervisor or his representatives but the supervisor or his representatives shall have final authority except as hereinafter provided.'

III. CONSERVATION OF OTHER MINERALS.

However, it is not only fuel minerals but there are various other minerals most valuable for our country, which are being neglected. Very little has been said and nothing done regarding their conservation. No country can afford to waste its mineral assets, and the prevention of waste becomes imperative when such minerals are limited in quantity.

India is by far the largest producer of *Mica*. There is no material which can be equal to mica in its heat resisting and insulating properties. Therefore it is an essential article for the electrical industry, and India's position in mica is so strong that if properly organized, she can command the world market in mica supply and sale.

In the fair province of Bihar, in the districts of Hazaribagh, Gaya, Monghyr and Manbhum, we have the finest mica deposits in the world. But although some of the mica mines, as those owned by Messrs. Chrestien & Co. and Messrs. Chatturam & Horilram, are well-equipped and fully modernized, still the larger number of them are owned by small capitalists and are exploited in a most ruinous manner. These small capitalists, possessing no technical knowledge, work the mica mines themselves or by their untrained managers without any machinery. Having no suitable pumps, they can go down usually to a depth of about 70 ft., i.e. until water difficulty makes it impossible to go down deeper. Thus they simply pick the eyes out of the mines in their ruthless search for the mineral, and after they have filled up their pocket with easily earned money obtained from mica recovered from near the surface, the outcrops are left inside the forests buried under the debris of the mines and the places are very soon overgrown with dense vegetation. Thus the outcrops of the mica mines are made obscure, and all such mines which may still be containing lakhs of rupees worth of mica in their depths, become unsafe for future working and are lost to posterity.

Theories about the origin of Indian mica, namely: (1) leaching out theory, and (2) absorption theory, which were in vogue in our country till recently, have made mine owners deduce that mica in a shallow deposit, that is, the mica mines cannot be continued very deep underground. According to the leaching out theory, mica was supposed to have been leached out of the surrounding country rocks by circulating water, and this idea was specially responsible to give a shallow-seated origin to mica, because the circulating water could not go very deep. These theories about the origin of mica might have had something to do with the wasteful mining methods of this mineral. It has, however, been possible for myself and my colleagues, Messrs. Sharma and Chattopadhyay,[40] to definitely prove that mica is a replacement deposit by solutions and juices that came up from the depth. This pegmatitic-pneumatolytic theory about the origin of mica is quite in keeping with those arrived at by the American geologists, specially Landes.[40a] The direct bearing of this theory to mica industry is that it has increased the reserve of mica of our country to many times of what was believed before, by taking the mica-bearing veins to extend much deeper below.

Another reason for the various faulty deductions about mica had been the policy of *laissez-faire* (as pointed out by the development of mineral resources in Britain twenty years ago). This has bred too much individualism and suspicion among the mica mining men. For this unnecessary zeal of guarding each other's secrets, mica mine owners never compare notes with each other to arrive at any general conclusion. Personally, I consider it is quite possible to compare notes with each other without divulging each one's secrets. I believe, it will be very helpful if the representatives of large mica mine owners, like Messrs. Chatturam Horilram Ltd., Messrs. F. F. Chrestien & Co., Ltd. and others, visit each other and try to learn from each other's experience, in a manner profitable to both parties. This is not being done at present in mica mines due to the fear of giving away secrets. It is true that in mica mines costs of production vary greatly from mine to mine. Not only in prospecting but I have seen that also in the working of the mines, each mica mine owner has certain line of work of his own to keep down the cost of production. These are of course secrets, but I consider it is easy to decide what information should be kept confidential and what information to be made public. In America, the law compels the mining industry to render a full account of their mines to the Government so that the Government can watch the progress and direct the industry whenever necessary. Unfortunately, in the case of metalliferous mines of India no such law exists to control and direct the working of the mines. Until recently there was no law to compel the mine owners to maintain a plan of mica mines shallower than 100 feet in depth. Even now the metalliferous mine owners are not required to keep a certified mining man as manager. But greater harm to the industry is being done by the adventurers who are working the shallow mines. As stated above, they are picking out the eyes of the mines and removing from the future generation all traces about the existence of a deposit. It is impossible to estimate the colossal damage to our mica resources done by these people. It is high time that something should be done to protect our mica mining industry from such seekers of fortune. There should be immediately a law to compel every mine owner to submit to the Mines Department a thorough and faithful account of his mines, their relation to the environments, and an accurate large scale (32″= 1 mile) map showing their position in the field. As such shallow mines are very short-lived, it will be better if such reports are submitted every six months. The Mines Department, as far as I know, has at present the staff just enough to inspect the mines once a year. This I consider very inadequate. The Department should have more staff to keep a stricter control over the metalliferous mines, small or big, because it is a common phenomenon in metalliferous mining that a deposit may look quite small and humble near the surface, e.g. the Phagooni mica mine (the biggest of the mica mines in the world producing the largest and finest mica), but it may be of tremendous value deep below. That is the reason why I say that a correct account of every mine and 'Uperchalla' work should be submitted. It is a natural tendency to avoid the hand of law as much as possible, therefore, unless there is a thorough control over these mines by the Government, it will be quite possible for the small mine owners and 'Uperchalla' workers to avoid submitting full reports. Hence, considering the importance of the metalliferous mines, specially those of the C.P., Bihar and Madras, I would go even so far as to suggest that in each of the mining districts of these provinces, a permanent Inspector of Mines, fully qualified in geological prospecting and metalliferous mining, should be placed. The Provincial Governments enjoy the royalty of minerals. If it be not possible for the Government of India to maintain Inspectors under the Chief Inspector of Mines to supervise the metalliferous mines as above, the Provincial Governments themselves should be well advised to maintain their own Inspectors in their mining areas to look after the mineral wealth of their provinces. The Bihar Government has already given a start by appointing a qualified mining engineer as their Inspector in Singbhum. The Baluchistan Government also employs their own Inspector of Mines. Their lead should be followed as soon as possible by the Bihar Government themselves in their mica mining district of Kodarma, Hazaribagh and Monghyr, as well as by the Governments of the C.P. and Madras in their own areas.

Everybody will welcome some kind of supervision that will safeguard the country from the dangers of ruining our mica mines and metalliferous mines in general, as far as practicable, without interfering with legitimate private enterprises. In India the State has so far generally concerned itself with levying taxes on mines. The State is also responsible for looking after the health and safety of persons employed in these mines. Unfortunately the State does not seem to have so far considered to take any interest in such questions as success or failure of greedy working of the metalliferous mines, i.e. quick profit-making by a sort of crash and grab method, detrimental or rather destructive to the mines. Now-a-days it is accepted on all hands that mineral deposits are national trusts and although nationalization may be a highly debatable topic, it is agreed that the mineral deposits of a country must not be wasted by adventurers. It is far better under such conditions to leave the minerals undeveloped.

One of the various types of iron ore found in the famous iron ore belt of Bihar is the micaceous hematite ore. This ore falls into powder when mined. Its iron content, however, is very high; more than 65%. Though this type of ore is briquetted and used for the extraction of iron in the Lake Superior region, U.S.A., it has no use at present in India because the powder chokes our blast furnaces. It can also be used for manufacturing 'Spanish red' (Ladoo R. B.—Non-metallic Minerals, p. 369, 1925). Thousands of tons of this micaceous hematite ore is thrown away every year in Gua and Noamundi mines of Bihar. Although our iron ore reserves are practically inexhaustible, that, however, is no reason for wasting it.

A remedy to remove this waste can probably be found in the recently developed Stuerzelberg process of the metallurgy of iron. The materials necessary for Stuerzelberg process are powdered iron ore, powder coal or coke-breeze and limestone. Large quantity of coke powder called coke-breeze is thrown away in the coke ovens every year.

Such a metallurgical plant can be started with a moderate capital outlay. The price of a small plant producing about 18,000 tons of iron per year is about 10 lacs of rupees; that of one of double capacity is about 17 lacs. The advantages of this process are that it is not absolutely imperative to have coke; the huge investments for coke ovens are eliminated. This process can produce pig iron with coal, anthracite, charcoal, or lignite, while the furnaces are heated with coal dust. Its slag can be used as cement or fertilizing lime. Eventually this process may conserve a certain amount of coal by the utilization of coke-breeze. By the Stuerzelberg process (Demag News, April 1938) two waste products of coal and iron industries can be well utilized in the manufacture of a very clean and valuable pig iron, the sulphur content of which is even lower than the valuable Swedish charcoal pig iron. The pig iron comes out of the Stuerzelberg oven in a thin molten state. Out of this, after the addition of alloying agents, casts can be directly made.

This process of iron metallurgy can also be recommended for the excellent soft and powdery magnetite iron ore of Mandi State, Punjab, containing as much as about 72% iron.

What has been said above about mica, can be repeated in the case of *Chromite* regarding the wasteful method of its mining in Bihar, and probably also in other areas. But here in case of chromite we have a mineral of great strategic value, in which our position is quite insignificant. Leaving aside the Baluchistan deposit, the deposits of chromite occurring in India proper are comparatively small and poor. Chromite is one of the most important minerals of warfare. Canons, shells and all sorts of tough steel require chromium. As the resources of our country in this mineral are very limited, chromite should be conserved. But not only there is no attempt at conservation of chromite in India but, as is the case with Singhbhum, all the chromite deposits have been left in the hands of adventurers who are quarrying the chromite to a depth of 40–60 feet from the surface, thus picking out the eyes of the chromite deposits, and filling up the old workings with debris as the work proceeds. If these old workings are not properly shown in a plan, all these heaps of debris will very soon be thickly overgrown by forests and all traces of chromite deposits will be lost for ever. The Singhbhum chromite deposits are peculiar. They, I believe, go very deep. Therefore, they should be mined and not allowed to be worked in quarries so deep. In the interests of the State, the best mining methods should be adopted in working them. It would be more to the interest of the country to leave such deposits unworked for the time being, rather than to work them haphazardly and wastefully.

I have pointed out above the wastes that are going on in the mineral industry of our country by irregular, unscientific and uncontrolled methods of working of the mines of mica and chromite. Other minerals fare no better.

Another great source of loss to the mineral wealth of our country is due to the very low price at which some of the very useful minerals, like *kyanite*, *magnesite*, *manganese*, *chromite*, *garnet*, *bauxite*, *beryl*, *ilmenite*, *wolfram* and *tantalum* and *vanadium* minerals are being exported out of India. The main reason why the Indian mine owner is selling these minerals, practically throwing them away—is that they have very little or no demand in India. In recent years due to the growth of large iron foundries, magnesite is finding a certain amount of local demand, but the bulk of magnesite as well as almost the whole of the kyanite, chromite and manganese and other minerals noted above, are exported at low prices to foreign countries. Best manganese ores are now sold at ridiculously low prices almost unheard of anywhere. Kyanite, the best refractory material known for making furnaces and crucibles for the melting of glass and to resist the action of silicate slags in general, a mineral in which India holds practically the monopoly of the world, is being exported even at such a ridiculously low price as Rs.27 per ton. Similarly low are the prices paid for chromite, magnesite and beryl, etc. The benefit of such low prices is enjoyed by foreigners. Indian firms have to buy kyanite crucibles and magnesite bricks as well as ferro-chrome and ferro-manganese ingots and tools manufactured abroad, paying very high prices, though India herself possesses all the raw materials necessary for the production of these materials. Even an inch of sand paper, all the ingredients for whose manufacture,—paper, garnet and glue—are found in India, is not locally manufactured.

Beryl is a mineral in which India holds the monopoly in the world market. Beryl is the only ore of beryllium. Beryllium metal resembles aluminium in lightness but it is brittle in unalloyed state. When alloyed with aluminium and heavy metals like iron, copper and nickel, in small quantities, beryllium alloys possess extraordinary strength, hardness and resistance to fatigue and corrosion[41] combined with lightness. These alloys are essential in making the body plates of zeppelins and aeroplanes. Beryl is sold to foreign countries at about £13 a ton f.o.r. rate. It is almost given away for nothing, while beryllium oxide, extracted from beryl, is a very expensive substance. It is sold at 10 shilling a pound. With so many efficient chemists all over the country, there is no reason why beryllium should not be extracted in India. Here again probably the state impetus is necessary, of course also cheap electricity. Our ilmenite, wolfram, columbite—tantalite, and vanadium-bearing iron ores require similar co-operation of the chemists, backed by Government encouragement, to extract titanium oxide, tungsten, tantalum and vanadium from their local ores for better economic advantage of our mineral deposits.

IV. REVIVAL OF CERTAIN FORGOTTEN MINERAL INDUSTRIES.

The discoveries of Harappa and Mohenjo-daro have shown that the people of India possessed a highly developed culture even in the 4000 B.C. They had used metals like gold, silver and copper in plenty, and lead and tin in limited quantities for making alloys.[42] It is believed that these metals were imported to these places in large quantities mostly from Indian deposits. Indians, therefore, must have possessed sufficient knowledge of working these metalliferous deposits and extracting metals from them.

Ores of metals like that of *Zinc* the metallurgy of which has been elaborately described[43] in ancient Hindu Chemistry dated 1300 to 1550 A.D., are now almost unknown among the mineral deposits of India. In the ancient Hindu books on metallurgy, the treatment of calamine has been specially described. As it can be seen from the table accompanying the map, zinc deposits occur in India proper in Bihar, Madras and the Punjab, yet very little is known about them. According to mineral production report (1936), no zinc was produced anywhere from the Indian deposits. Even the important lead-zinc deposits of Kashmir[44] are not worked for zinc now-a-days. Being in limestone the deposits seem to be of the nature of gash veins and therefore of a specially uncertain nature. For that reason it is not finding any favour with the present industrialists of India although very large quantity of zinc is used in our country for zincing the corrugated sheets and many household articles. I believe if investigated by geologists with experience of this type of ore deposits, some of the lead-zinc deposits of Kashmir and other areas might eventually be found useful. At present the zinc deposits are one of the neglected mineral deposits of our country. Whether these deposits were known to the ancients is not stated in the 'Rasharatna Samuchaya', but the elaborate metallurgical procedures given in that book leaves no doubt about the fact that ancient Indians had a thorough knowledge of zinc ores which probably occurred in sufficiently large quantities in India.

'Rasharatna Samuchaya' deals with the chemistry of many other minerals and sometimes also mentions the places of their occurrence. Thus, for instance, it mentions the presence of copper pyrite deposits in the land of Kiratas, Chinese and Javanas. The Chinese deposits probably refer to the copper deposits of Sikkim. The deposits worked by the Kiratas and Javanas may be those of Mosaboni and Monipur areas. The latter areas were until recently being inhabited by aboriginal people.

There are extensive application of *Mercury* in Hindu Chemistry, especially in the Hindu Science of Medicine. No important deposit of mercury is at present known in India. If at that time cinnabar was not imported from foreign countries, especially China, mercury deposits are yet to be discovered in India. Bagha Bhatta only mentions that Giri Sindura (cinnabar), from which mercury was manufactured, occurs among the big mountains. Where these big mountains were, no mention has been made.

Where are the *Sulphur* deposits of India, a substance largely used by the ancient as well as medieval Indians ? Until recently even during the Moghul and Marhatta rules, all the sulphur required for the manufacture of gunpowder of the formidable Moghul and Marhatta armies seems to have been obtained locally. Sulphur deposits are known to occur in Kalat District of Baluchistan and in the dying volcanic island, the Barren Islands, in the Bay of Bengal. One of the members of this group of islands is known as Narkunda, probably distorted form of Sanskrit name, Naraka-Kundam. From its Sanskrit name, it seems the place was known to the Indians and probably they used to obtain their supply of sulphur from this place. At present the supply of sulphur at these places seems to be insignificant. Certainly, however, these areas require to be properly investigated for sulphur.

It may also be that ancient Hindus were extracting sulphur from pyrites. When engaged in geological survey work among the Nickel-Cobalt deposits of Eastern Nepal (1935), I heard that all the sulphur used for the manufacture of gunpowder in Nepal was until recently extracted from iron pyrites. In fact, wherever I looked for a deposit of sulphur, I found it actually was a deposit of pyrites or marcasite, the latter with traces of nickel. The art of extracting sulphur from pyrites seems to be gradually dying out in Nepal. It may be very useful for the scientists of Nepal to make a thorough local investigation and find out the procedure followed in their country for recovering sulphur from pyrites. Then this process, which is likely to be a simple one, may be a very important contribution to the manufacture of heavy chemicals in India, and might ultimately be found useful to save about 20 to 25 tons of sulphur, that is being burnt away every day in the metallurgical plants at Mosaboni, Bihar, at the time of the recovery of copper. This is a matter of shame for us in view of the fact that India is so much insufficient in her sulphur resources and she has become solely dependent on foreign sources for supply of sulphur. India's total need of sulphur is about 10,000 tons annually. In this connection I am very happy to know that Dr. M. S. Patel, formerly Industrial Chemist to the Government of Bombay, has recently sailed for Europe and America to visit the factories in Sweden and Canada, where sulphur is recovered during the metallurgy of chalcopyrite as a by-product of the copper industry. I do hope that Dr. Patel's efforts will meet with success, and that he will come back to India with all up-to-date knowledge of the recovery of sulphur from sulphur dioxide gas.

'Mention is made of gems and jewels in the earliest writings of the Hindus. The Vedas speak of a place illuminated by rubies and diamonds, which gave out light as refulgent as that of the planets. Precious stones play a prominent part in the mythologies of the Hindus and in their traditions, poems and legends. In the two great epic poems of Hindustan, the Ramayana and the Mahabharata, frequent mention is made of stones and pearls with which kings and people of the period used to decorate their person'[45]. According to Hindu Chemistry (p. 99), the Hindus used to possess a good knowledge of the following gemstones:—

Vaikranta, Suryakanta (sunstone), Hirakam (diamond), Mauktikam (pearls), Chandrakanta (moon-stone), Rajavarta (lapis lazuli) and Garudodgara, the emerald (lit. derived from the vomit of Garuda). The topaz, the sapphire, the coral and the cat's eye are also reckoned among the gems. Ruby and zircon are also mentioned.

Though the description of jewels and gems are meagre and vague, yet there is no denial of the fact that all the *Diamonds* that the world saw till the middle of the last century, came from India. The diamond deposits of India were still known to produce diamonds when they were visited by the early geologists of the Geological Survey of India, King[46] and Ball[47]. According to them, some of these deposits were still paying in the seventies of the last century. At present no diamond is mined in India in her once famous deposits, but 'private but unconfirmed reports indicate that every year a certain number of valuable diamonds are picked up after showers of rain in the neighbourhood of Wajra Karur in the Anantapur district of the Madras Presidency. One was recently found in a field north of the pipe, calculated to be of sufficient size to yield a table diamond of sixty carats, worth about a lakh of rupees'[48].

Diamond occurs in India in three different geological horizons, e.g. (1) in Karnul and Cuddapah systems of Cuddapah, Anantpur, Bellary, Karnul, Kistna and Godavari Districts of South India, (2) in the Vindhyan Conglomerates of Panna, Charkhari, Bijawar, Kothi, Pathar and other states of Central

India, and (3) in the placer sand deposits of the Mahanadi valley in the Sambalpur district of Orissa and Chanda district of Central Provinces.

Until the middle of the last century 98% of diamond found in the market was supplied by India, while at present we rarely come across an Indian diamond. Some of the most famous diamonds of the world, namely Kohinoor, Orloff, Hope, Great Moghul, Saucy, came from India. What has happened to the deposits that produced these world famous diamonds? For unknown reasons the diamond industry of India has died out altogether. The diamond mining industry is another mineral industry which requires our attention for its revival.

Gold is distributed more widely throughout India than any other useful mineral with the exception of iron ore. I shall confine myself only to the placer deposits of gold. The very names of some rivers and villages, e.g. Subarnarekha and Sonapet in Bihar, Subarn siri and Dhan siri in Assam, Sona in U.P., Dhanpur in Mandi and Sohna in Delhi, convey the idea that gold washing had been carried on in their valleys for a long time. According to La Touche, 'Under native rule Assam is said to have enjoyed a high reputation as a gold producing country, but several reasons have combined to render the industry unprofitable, and within the last 60 years it has become practically extinct'[49]. Panning in the Subarnarekha (golden-streaked) river in Singhbhum, Bihar, was carried out sometime back by my students near Ghatsila, and the gold content in the river sand at one place was found to be 1 dwt. per ton. Recently I have found that at places the gold content increases in the sand and alluvium as we go away from the river bank, and in one case in Seraikela State, small nuggets of gold were discovered after panning up a hill. These do not show signs of any appreciable transportation and hence indicate the presence of rich gold-bearing reef in the vicinity.

Regarding the working of placer deposits of gold in India, Ball says, 'Gold-washing, as practised in India, affords an example, I believe, of human-degradation. The colonies of washers, who are found, plying their trade in most of the areas where geologically speaking, the occurrence of gold is possible, must be regarded as remnants of people possessing special knowledge'[50]. But who is responsible for this degradation of the expert gold-washers and the dying out of the gold-washing industry from India?

The hope of reviving the placer diamond and gold industries lies in tackling the geology of their deposits in broader lines. Since the closing down of Indian diamond mines and the workings of placer gold, sometime in the middle of the last century, many improvements have been made in the technique of mining and concentration of diamond and gold from the gangue. Pumping machines have been discovered, many hundred per cent more efficient than before, or, during the last quarter of the nineteenth century. Mechanization of every branch of mining has made it possible to increase the output of raw materials. The old method of concentration is now out of date. Newer methods, as are at present employed in Africa and Brazil for the concentration of diamond from the crushed Kimberlite and placer deposits, have not only made the concentration process more economical, but have also made it possible to separate the complex ore from the diamond itself, which was formerly supposed to be impossible. It, therefore, seems to be quite reasonable to propose that the diamond and gold industries of our country which formerly must have supported many thousands of men, and undoubtedly added much to the country's wealth, should be revived again in the light of modern mechanical devices, as in the mineral industry we find innumerable examples of many deposits hitherto looked upon as too difficult and complex to exploit, are today capable of being worked economically. Probably the start may be given by the State. In these days of Provincial Autonomy although the laws for safety and supervision are vested in the Central Government, the direct benefit derived from mineral royalties belongs to the Provincial Governments. It is, therefore, quite reasonable to expect that the first start to open any new mineral industry should be given by the State. It is true that the State cannot conduct an industry as efficiently as companies or individuals, whose livelihood depends upon the result of their efforts, but that does not mean that the State should remain indifferent to show how certain mines can be opened, exploited, and worked[51]. A great disadvantage to the opening of these mines will be due to the fact that the tradition has now died out. It will be at first necessary to train the new generation in the now highly mechanized art of mining. Unless the State takes the initiative, it will not be possible for individuals to venture on a new enterprise like this. In Japan this is a common policy of the State. In India too the same should be the policy, especially of the Provincial Governments and States, to bring back India gradually to the state of her past glory.

I have already tried to make out a case for re-opening of zinc, sulphur, diamond and gold mining industries of India. Not only in diamond, but there exists in India a very good scope for re-starting our trade in a few other *gem-stones* like aquamarine, topaz, rock crystal, garnet, spinel and ruby. Several years ago, I had an occasion to examine a mass of mineral which was being exported by a Jaipur State mineral contractor to foreign countries as beryl. On examination I found that a good portion of it was really aquamarine, a semi-precious stone worth about a shilling per gram. This valuable mineral was being exported at a price of £13 per ton. Lack of proper knowledge of the substance and its uses and possibilities on one hand, and lack of proper supervision of the mines by a properly trained man on behalf of the proprietor on the other, have been the main causes of this kind of waste. It is high time that the respective Governments of the various provinces in which these minerals occur should stop such wastes, and devise some means to protect such valuable minerals which are being irrevocably lost on account of ignorance.

V. CONCLUSION.

In the foregoing pages, I have indicated the urgent necessity of conserving our mineral wealth, which is being wasted these days recklessly, and have also suggested that certain new mineral industries may be started and old mineral industries revived, with the co-operation of geologists, mining engineers and chemists, backed by Provincial Governments. There can be no revival of any industry, specially of the mineral industry, unless and until the general ignorance of the people about their value and uses is removed. Every Provincial Government must have a local Geological Department in charge of an efficient geologist to remedy this defect.

Once it was said, 'Hitherto the natives, however intellectual, and however well they may have been educated in various scientific branches, have shewn but little capability for undertaking original scientific research, and, indeed, they seem to be deficient in synthetical powers to an extraordinary degree'[52]. These were words of a thoughtless geologist of the last century, inexperienced in Indian culture. Forces like this, that were at work from time to time, to deny, belittle and ignore the attainments of India, have been duly silenced by the fact that India has now produced men like Brojen Seal, J. C. Bose, P. C. Roy, Gandhi, Tagore, Raman, Meghnad, Birbal, Wadia and others, whose intellectual attainments will make any nation proud.

Geology not only needs an analytical mind, but also a certain amount of philosophical outlook is necessary. The greatest contribution of India to the world civilization is her philosophy. Human thought did not possibly extend further in any other country during any civilization than that in India, as exemplified in her philosophy. It was once possible for India to produce sages and seers who rising into sublimest heights of intellectuals and spiritual eminence, dived deep into the unfathomable depths of soul, nature and into what is beyond and above nature, the infinite, and wrung for mankind real knowledge, knowledge of self and unself, and of the Supreme Being[53]. The nation with such a tradition cannot be said to be lacking in the much infinitely simpler synthetical power necessary for geological deductions.

Indian Universities like those of Benares, Bombay, Calcutta, Madras, Mysore and Punjab, as well as the Indian School of Mines, Dhanbad, are now-a-days producing very efficient and capable geologists qualified to take up the mineral investigations in our country, and to do the spade work necessary in the beginning for the conservation and revival of India's mineral trade[54]. The Provincial Governments will find all their requirements for prospectors as well as mineral advisers in the young people coming out of the educational institutions, named above. These young men should not only be employed in their respective provinces to investigate the mineral resources of the provinces, but the Provincial Governments may even go to the length of granting them advances, and subsidize them to develop the mineral industries of India. As has been pointed out by King and Dunn (*loc. cit.* 46 and 54), there are many mineral deposits in India which will give a moderate return to suitably qualified persons who have a small capital and are willing to lead a hard life. Such young men will eventually remove our lack of knowledge about the various mineral deposits all over our country; they will educate the mass to the usefulness of minerals and remove ignorance about them. In this connection, I have much pleasure to add that one of my colleagues, Mr. N. L. Sharma, has recently published a most welcome volume in Hindi on mineral wealth of India[55]. All these efforts would eventually lead to the conservation of our mineral wealth and to the re-opening of many deposits of the neglected and unknown minerals of India.

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SECTION OF GEOGRAPHY AND GEODESY

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Presidential Address

THE GEOGRAPHICAL PERSONALITY OF INDIA

CONTENTS.

Page
Introduction 99

PART I—STATIC GEOGRAPHY.

Greatness of the Punjab (2) 100
India, a Geographical Personality, not a mere geographical expression; natural Frontiers (3, 4) 101
Climate, Physical Elements (5–15) 102
Self-Sufficiency, Isolation, Caste and Castism (16–20) 107
Many-sided Variety (21–43) 109
The Cultural Lag, whereby the West is ahead of India (44) .. 117
Nature's Gifts to India; and Man's Use thereof (45) 117

PART II—DYNAMIC GEOGRAPHY.

Dynamic Geography, study of forces making change (1) .. 118
India linked to the World (2) 118
No Isolation except in World Politics (3-4) 118
Caste adapting itself (5) 119
Self-Sufficiency breaking down (6) 119
Towns and Cities, Centripetal (7) 119
Cultural Lag: universities, illiteracy (8) 120
Dynamic Geography emphasizes Progress, examples (9–21) .. 121
World Progress; and Disequilibrium (22–28) 125
Caste and Occupation (29-30):
  Example of Parsis 128
  Regional selections by Indians from British examples .. 129
Cultural Contacts (31–39) 129
Indian's Reactions to British Types (39–41) 132
Britisher's Reactions to India (42-43) 135
Indian Examples (44) 136
Room for Improvement (45):
  Dayalbhag 138
  Gandhiji 138
  Capitalist 138
India in Transition; Western Spirit; some present difficulties (46) .. 138
Conclusion 139

INTRODUCTION.

My first duty is to thank, on behalf of Geographers of India, the authorities of the Indian Science Congress Association, for their constituting permanently Geography and Geodesy as a separate section. Such recognition of the importance of Geography by the Premier Science Association of the land will prove of help, it is hoped, to stimulate Geographical Thought and Research in India.

In this Address, I propose briefly to deal with 'The Geographical Personality of India', and dwell upon some Leading Geographical Elements in Indian Life, past, present and future; and I shall indicate, from both the physical and the human sides, their basic and dynamical aspects. The theme is vast and every statement should bristle with exceptions, only too many; still, it is of value to have a synthetic and panoramic view of those several forces at work, as they are only too often lost sight of.

PART I—STATIC GEOGRAPHY OF INDIA.

Greatness of the Punjab.

2. 1. We are met to-day in the Punjab, a Region whose greatness is pre-eminently the gift of its Geography. Its situation at the head of India has given it importance throughout History; its fat plains, overflowing with milk and honey, respond to the generous touch of water, yielding yearly corn and pulses and oil in abundance. Great as theatre of wars in the past, it is to-day the field where victories of peace are garnered, witness the engineering triumphs of the triple project; the several Waterworks and Hydro-Electrics; or the Canal Colonies.

2. 2. *Punjab, a Cultural Cradle.*—Sheltered behind natural frontiers of loftiest ranges and spreading along mightiest rivers, it has been the cradle of Indian Civilization from Pre-Historic Times. The Soan Culture; the Harappa Civilization linked to Mohenjo Daro; the Dravidian or Sumerian and the Vedic Civilizations—all have had here their growth and development. To the Punjab belong the great names of Sanskrit literature, Vyasa, Panini, Patanjali; Kurukshetra; the Kuru-Panchalas and the Gandharas; King Poros; King Kanishka; the long line of Kashmir Kings; the great monarchs of Afghan Dynasties and the Mogul Emperors of Delhi; and kings from Prithvi Raj to the Sikh Ranjit Singh who ruled with supreme dominion over the Northern Punjab and N.W.F. Province.

2. 3. *Punjab, varied folks.*—In historical times, the mountain ramparts guarding the Punjab opened their gateways only to peoples more powerful at the time and shut them on the weaker ones—Persians and Greeks; Sakas and Huns; Arabs and Afghans; Tartars and Moguls. It is only the last conqueror—the Britisher—who has come to the Punjab by way of the plains through the Sea-gate of India; and he, too, though himself no settler, has dowered it with his gifts of war and peace, enriching it like every other race and religion before.

2. 4. *Punjab, Great in the making.*—The British Sergeant has been very much abroad in the Punjab; and better disciplined men in the rest of India or even the world, there are none. The Hindu, Rajput, Jat, Mussalman and Sikh, all animated with burning zeal for their religion, have been bred to arms and can wield with equal dexterity the pen and the sword, vying with each other only in their willingness to render service. The modern composite civilization of India is developing best in the Punjab; and the strength of the Punjabi is the strength of India. The Punjab is India in miniature and India is a miniature of the world.

India, a Geographical Personality, not a mere geographical expression ; natural Frontiers.

3. 1. *Personality of India.*—Though a Microcosm in her infinite variety, India has her own Personality, great, powerful and strongly marked off, by prominent features, from other countries of the world. From Cape Comorin to the Himalayas, from the Yomas on the East to Eastern Afghanistan on the West, there is a Geographical Unity binding land to land in bonds of Sun and Wind and Rain, varied by relief and the sea. The fundamental unity is that of climate, which is hot and monsoonic, the cold season even of North India being but of short duration. There is, besides, a unity of civilization, colouring, shaping and regulating the lives of her men and giving them a common outlook. Historically, various cultures have entered into the making of her civilization; and in the diversity and range of those cultures lie the greatness and comprehensiveness of Indian Civilization.

3. 2. *India, a Geographical Expression.*—India, it has been said, is a Geographical expression, a saying adapted from Metternich and intended to stress the political disunion and want of cohesion evident at present. But her true frontiers have been set out by Nature; her civilization has been developed and evolved so as perfectly to befit and envelop her as her atmosphere. And if political union remains the last to be achieved on Indian Soil, slow as it is in coming, the struggles that are witnessed are but the pangs of its birth.

3. 3. *India's Frontiers in History.*—Throughout the ages of her long history, the dictates of her Geography have impelled her rulers to extend their realms to the natural frontiers. Political union has been the aspiration of her great rulers. That was the urge behind the Hindu Aswamedha (the Horse Sacrifice) of old, celebrated by the Powerful Monarch of the day in order to become the Suzerain (Samrat) and bring all India under one Umbrella (Ekachhatradhipati), be he the legendary Raghu or the Pandava, the historical Pushyamitra or Samudra Gupta. That was the urge behind the Moslem conquests of the Sultans and Padishahs of Delhi—Sher Shah, Akbar or Aurangazeb. The

dictates of Geography it is that has been the urge behind British Expansion in India, through Wellesley, Ellenborough, Dalhousie or Curzon, successors all to the Great Mogul, eager to enter upon the entire heritage of the Mogul.

3. 4. *Some countries not within.*—Alone of the Mogul heritage, Afghanistan and the Hindu Kush have kept out of the British System, cherishing their innate Love of Liberty and their Independence; while the differentiations of the two centuries have made them quite distinct from India. They were once Hindu and Buddhist before embracing Islam; they have had relationships of race and language and religion with the West Indus Regions. Historically, too, they were linked with India under Hindu, Buddhist, Afghan and Mogul Rulers, until about hundred and twenty years ago.

3. 5. *Variations.*—Other countries have now and then come into, and gone out of, the British Indian Empire. It is India's destiny to win for British Raj territories like Burma and develop lands like Natal and East Africa until the Indian ladder is no longer wanted. Other such examples are Aden and Singapore. They do not belong to India.

3. 6. *Ceylon.*—The contiguous Island of Ceylon, but for modern political accidents, ought to have been part of it, by virtue of geographical unity, of similar civilization, and of ethnic affinities, both the Sinhalese and the Tamils there being but immigrants from the mainland.

3. 7. *Why, the Historical Difference.*—In establishing an Indian Empire stretching to the farthest extent of natural limits, the British have succeeded where their great predecessors failed. But then, the British have, at their command, all the resources developed by the knowledge of the West—by knowledge created only in modern times and, therefore, not available, to the former rulers of India,—for the purpose of mastering the baffling immensity of the problems, such an Empire presents.

4. 1. *India, a Sub-continent.*—It should be remembered that India is a Sub-continent, considering her vast extent, her great size, her immense and diversified population, or her infinite variety. Thereby, every Indian question is rendered multiform and manifold, and made more complicated and difficult than are such questions in other countries. Be it the problems of defence or poverty, the removal of illiteracy or the conquest of malaria, the reconstruction of villages or the building of roadways, their magnitude and proportion underscore every effort and have first to be tackled and overcome and provided for, before any appreciable results can be perceived.

Climate, Physical Elements.

5. 1. *Climate.*—The climate, which stamps this extensive region with its unity, is moulded by India's situation and configuration.

5. 2. *Situation.*—On the face of the globe, her situation is half within the tropics and half within the temperate zone, which is however contiguous to, and in unbroken continuity with, the tropical part, and by consequence partakes of its features. And she stands a Peninsula at the head of the Indian Ocean, flanked on either side by receding land masses, which reach down to South Africa on the West and to Australia on the East.

5. 3. *Configuration.*—Her configuration is a quadrilateral, whose two Southern Sides jut far out into the sea and whose Northern Sides cut her off from the land masses of Asia by huge mountain barriers of far-flung mountain ranges.

6. 1. *The Sun.*—Over the region thus bounded, the sun dominates fiercely; it burns with tropical and sub-tropical intensity, flooding it with blazing light and heat. The sun helps in making the soil; and, (according to Dr. Dhar, the Bengali chemist) is the more potent factor in its nitrogen fixation. The energy of the sun calls up a luxuriant growth of tropical vegetation where water and other conditions of plant life are present. The sun gives the Indian warmth, health, and wealth.

6. 2. *The Seasons.*—The regime of the sun has a marked influence on the cycle of the seasons, which in South India are described as hot, hotter, and the hottest; while in North India the hot season is succeeded by a cold winter of only about four months' duration, unaccompanied by snowfall and frozen rivers on the plains. In essence, India is a hot land, one of the hottest on the globe, temperature ranging from about 4°F. in the remote South to 40°F. in the far North.

7. 1. *Wind Circulation, The Monsoons.*—The difference in the sun's heating of land and water in the Northern and the Southern Hemisphere in spring and summer and in autumn and winter, creates extensive and mobile areas of low pressure; and generates the circulation of the winds, which, in India, definitely follow the seasons and are therefore called monsoons. They set in steady direction from the South-West in spring and summer, veering to the North-East in autumn and winter. By these winds, nature tempers the climate to the people. For, the former, the S.-W. coming from the relatively cooler southern seas, brings clouds and rain to mitigate the heat; and the latter, coming from cold masses, makes the cold season so very delightful.

7. 2. *Wind and Heat.*—The winds influence the temperature of the lands over which they blow, not only with their intrinsic hotness or coldness but also with their dryness or humidity. Hence the steaming heat of Bengal and the dry heat of the Punjab in summer; the bitter cold of Sind in winter and the humid cold of Eastern Himalayan Regions.

7. 3. *Wind and Power.*—The prevailing winds blow over large tracts of country with steadiness and regularity for long spells at a stretch, and can be a primary Source of Power in

India; and it is a wonder that it has not been yoked to the service of man by wind-mills designed to suit the several velocities of wind at the place.

7. 4. *Wind, Cyclones.*—It is not unusual in India for gusts of wind to blow gales and hurricanes and cyclones; when they occur they spread devastation before them over hundreds of miles, felling trees, destroying houses, cutting up embankments and scattering boulders and rocks. Some of these have been known to career across, in unabated fury, from the East Coast to the West, a distance of over 300 miles.

8. 1. *Water Circulation, the Monsoon.*—Intimately connected with the wind is the circulation of water. In so agricultural a country as India, the importance of water cannot be over-rated; indeed, it is said even of the Government of India that its finances are a gamble in rain. The people are accustomed to watch the skies for the monsoon-burst, the break of the monsoon; the village *Panchik* (the calendar-man) ekes out a livelihood, by forecasting for his place, the raininess of the year and its dates, as handed down to him and taught him by local observation, by a sort of rule of thumb.

8. 2. *Its Regularity.*—Fortunately, the monsoon rains, in a normal year, are regular, almost punctual, and visit places at appointed dates, as it were, like an Ocean-liner. The distribution of rainfall over the several dates is equally important with the quantity of rain falling; for, the several agricultural operations are timed to both.

8. 3. *Local Rain.*—From the wind-borne rain-clouds, each place gets of rain what it can, by virtue of its relief, both in elevation and aspect; of its situation such as proximity to the Sea; and of its hotness, too. The highest rainfall in the world, over 500 inches, is at Cherrapunji in the East, in the Khasi Hills, the farthest destination of S.-W. winds; and on the West, Jacobabad, which is in the region of the Indian desert (desert, for want of rain) has under 5 inches of rainfall. The plains of India are a great evaporating cauldron, the sun and wind evaporating agents; while the lee side of mountains suffer often from Drought.

9. 1. *Tank and Well.*—Excess of rain or its want or its inadequacy makes abnormal years; and against such visitations, a net-work of tanks impounding surface-water and linked, it may be, in series, and of wells tapping underground water, studs the lands where they are incident. These make some sort of provision against threatened Famine.

9. 2. *Rivers.*—The principal life-giving waters in India are her rivers. The Indus, the Ganges and the Brahmaputra, from their Himalayan snows to the sea, along with their tributaries from the Himalayas, the Western Mountains, the Aravallies and the Vindhyas, make the soil and support life, spreading fertility over all the vast Indo-Gangetic plain. Together, they form the

largest, the longest and the mightiest of river-systems, ever utilized by man. Their relief and gradient provide sources of power which have but just begun to be tapped.

9. 3. *Canals.*—Dams have been built across them; and hundreds of miles of canals, taking off them, water millions of acres and sustain human life by the million, where the bison browsed and jackals used to howl.

9. 4. *Southern Rivers.*—Other great River systems, south of the Vindhyas, flow across the mainland; but they are not snow-fed; and not all of these have been fully utilized. The best utilized are the Godavari and the Krishna and the Cauvery; and the least, the Narmada, the Tapti and the Mahanadi.

9. 5. *Floods.*—Sometimes, these Rivers overflow their banks; and then those floods are irresistibly destructive, as in Bengal in September last when over 20,000 square miles were submerged by them.

9. 6. *The Flood Problem.*—As an example of Indian problems, it may be stated that a committee was appointed so recently as August, 1938, to study the Mahanadi system with a view to building dams across it, if only to prevent its frequent and destructive floods; one attendant circumstance being that, where it emerges into the plains, the area irrigable by canals is small relatively to the cost involved.

10. 1. *Drought and Famine.*—Whether rain-fed, river-fed, or canal-fed, lands in India are frequently subject to droughts, and then the gaunt spectre of famine stalks over the land. Modern Transport brings relief to distressed areas; and upon their experience, the British have built up a regular Famine Code to deal with it promptly and to mitigate its incidence. But modern famines, however, are due to want of pence rather than want of water, to economical rather than geographical causes. Be that as it may, the loss of human life is appalling; and that of cattle is beyond description.

10. 2. *Famine of two Kinds.*—Famine is said to be the skeleton in the cupboard of British India; but it is true also of Indian India and Past India. Geography reveals the true character of famines by polarizing the famine into two, and showing how that part which is due to Geographical factors is ever being alleviated, instead of being aggravated, by expansion of irrigation and similar public utilities.

11. 1. *Coast and Sea-life.*—India has an extensive Coastline of over 3,400 miles—over 4 times Germany's—presenting on the East Coast surf-beaten and breaker-swept sandy shores, and on the West Coast, many a land-sheltered cove and harbour. Fishermen still ply their drag-nets, and *catamarans* and *masula* boats still ride on the surf, as in ancient days. It is a fact that the frail boats of India, following the wind, carried in those days Indian commerce and civilization to such distant countries as Sumatra (Sri-Vijaya), Java (Hindu remains from 1st cent.) and

Borneo (Yupa, Sacrificial post of VI cent. A.D.); to Indo-China (Angkor-Vat); and Canton; and Japan (Bodhi Sena of South India, there in VIII century A.D.).

11. 2. *The Sea-sense.*—But the sea-sense has not had a strong development among Indian people. The coastwise plain is cut off by high relief while the foci of Indian Civilization have been too far away in the Inland to receive the influence of the sea and to be influenced by Kaveripatnam or Musiris (Cranganore), Kalinga or Dwarka.

11. 3. *Indian Seamen.*—When the need arose, the Mahrattas of the West Coast developed into seamen, building ships and manning them; and the seamen of Chittagong are even to-day esteemed as laskars on British Liners.

11. 4. *Landsmen in Modern Crew.*—Such is however the modern division of labour that bands of men from Amballa, for example, (more than 600 miles from the nearest sea) find employment as firemen in British Steamers.

11. 5. *Sea, as Defence.*—So impossible it was to invade India by Sea in ancient and mediæval times that the Indian Poet, Kalidasa, conceived of the Coastline as Ramparts and the Seas as Moats, together forming an impregnable defence. But the compass and the gun have made the European in his floating castle master of the sea and all it circles. And the Command of the sea it is that has given India to the British, keeping out every other European rival.

12. 1. *Mountains as Defence.*—The Mountains form another impregnable chain of ramparts, extending and completing the sea defences. The high, huge, and extensive Himalayan Systems are over 1,800 miles long; the Eastern mountains are clad with impenetrable forests; and on the West, high bleak mountains protect India, opening only at seven passes. But it was through them that there poured into India all her invaders and conquerors but one. The British alone have come by sea, at first as traders; and later on transmuted themselves from traders into rulers by the heat generated in the politics of India's rulers of XVIII Century.

12. 2. *Mountains as Barriers and Frontiers.*—These mountains still remain, what they have been, the natural Barriers and Frontiers of India; and the military concentration is in the Punjab and N.-W.F. Province, where the Indian army keeps incessant watch and ward against the virile and warlike tribes of the borders and races of Afghanistan and Central Asia.

13. 1. *Forests, Varieties.*—Forests play a large part in India's economy. They are of various types, sub-equatorial as on the West Coast, growing teak and jack and sandalwood; subtropical growing the sal and blackwood; alpine as in the Himalayas with deodar and *chir*, and juniper; terai at the Himalayan foothills with giant grass and bamboos, sheltering elephants; while all over may be seen the scrub jungle preserving game. Where

forests are, there water is conserved, soil preserved from erosion, temperature lowered, and rain attracted.

13. 2. *Forests as Home.*—The forests have been the home and defence of the aboriginals and fugitive peoples, protecting them in their independence, as witness the Bhils, Oraons, Mundas, Gonds, Kolas of the Vindhyas; the Santals and Khonds of Chota Nagpur; the Savaras of Agency Tracts of Ganjam; and the civilized Garhwals and Nepalese, in the Himalayas.

14. 1. *Plateaux.*—The Plateaux have been so subdued to civilization that they are different from the plains only in the regime of climate and the potential power that relief may give them by way of waterfalls, etc. Such are the C.P. and Mysore.

15. 1. *Plains, the Pagoda Tree.*—The vast Plains of Hindustan, provided with no natural defences save their own extensiveness like the Russian, fertilized by its mighty rivers, and civilized from ancient times, have been the cynosure of the world; and the wealth of India has been the standing temptation to all the world, through all the ages. Here grew the fabled pagoda tree to be shaken by the strong arm, in order to bear and yield its fruit. The land is wealthy still, bearing rich harvests and producing the manufactures of industrious folks.

Self-Sufficiency, Isolation, Caste and Castism.

16. 1. *India's Self-Sufficiency.*—The first prominent feature of this extensive country has been its self-sufficiency. With its rich harvests, its famous looms and artisans, it used to meet and, for the greater part, meets, to this day, most of the natural needs of civilized life by way of food, clothing and shelter.

17. 1. *Isolation.*—The most natural consequence of such a condition is Isolation. This has been intensified by the Mountains which cut off India from her neighbours and by the Seas separating her from other countries by hundreds of leagues which were almost impassable by old-time ships. The mountains of the mainland have erected yet other barriers between the same folks and have carried the isolation further by creating inner isolations, isolation within isolation. Add to these the great forests and the different rainfalls and we have a geographical view of that double isolation.

17. 2. *Isolation within Isolation, Examples.*—For example, from Bombay in the North to Cape Comorin in the South, we have the Mahrattas, the Kanarese, the Coorgi, the Malayalee, each feeling himself distinct, and jealous of his distinctness, from the rest of the world. From West to East along the Vindhyas, there are Hill Tribes feeling likewise; and Subregional Criteria such as mountain, forest, temperature and rainfall differentiate the Punjabi, the U.P. Wala, the Biharee and the Bengalee, from one another, feeling each with gladness that he is not like the rest.

17. 3. *All making for Rigidity and Variety.*—One result of such isolation is the insusceptibility to outer influences as such;

a rigidity within the larger framework. For the very same reason, there exists a rich variety in India of cultures differently evolved, each tenaciously holding by its own.

17.4. *Isolation in Neighbourhood.*—The peculiarity of the inner isolation is that it is isolation in neighbourhood.

18.1. *Toleration.*—From this twofold character, there have sprung up in India widespread Toleration; a willingness generally to live and let live; and an all-embracing catholicity of spirit.

18.2. *Simplicity and Subjectivity.*—Again, the necessity of making the best of the area to which they have confined themselves voluntarily or otherwise, has given rise to pervasive simplicity and intense subjectivity. Plain living and high thinking still commands respect in India (e.g. Sir P. C. Ray, Gandhiji).

18.3. *Spirituality.*—Further, all these factors have contributed to make India stress more the spiritual side and provide her with varieties of religious experience. It is sometimes said that the history of India has been the history of her saints. From the Vedic seers to Buddha, from Mahavira to Vivekananda, from Guru Nanak to Ram Tirath, there have been towering peaks of religious teachers, raining their influence upon myriads of their followers. Srijut Aurobindo Ghosh is the latest Seer in the long line of India's spiritual mission. Even Emperors like Asoka and Akbar live on by their spiritual enlightenment while the glory of their regal splendour departed with them.

19.1. *Stability of Indian Civilization.*—These and other such factors have imparted, to Indian Civilization, the quality of Stability; and it has been able to survive the pomp of kings and circumstances of war; the tramp of invaders and marauders; and the insidious attractions of a different life.

20.1. *Caste and Castism, all-pervasive in India.*—Next only to Isolation in range, and re-inforcing it with its ever-present power, stands Caste in India. It may have evolved at first as occupational differentiation; or as a mode of living together, side by side, of two different folks, without letting each be absorbed by, or in, the other. Caste has dovetailed itself into the map of Life in India so perfectly, and plays its part so completely in domestic economy that even conquerors like the British, who, in their own home, have none of it but class differences, manifest symptoms of castism here. To remain aloof outside the contacts of business; to live, move, and have their being in worlds of their own kith and kin or race, may be merely the psychology of birds of a feather flocking together. A dread of miscegenation of two hostile or alien races or religions looms behind.

20.2. *Caste and occupations.*—But in India, caste has developed further into trade guilds and occupations. Even now, in cases where there is equality of opportunity, Caste determines the choice, understanding by the term caste not only the Hindus but those others in India who observe it in all but name—the casteless Quasi-Caste. Of course, its ugly feature is the principle of hereditary occupations with resulting stagnation and the habit of looking up and looking down on one another.

20. 3. *Caste, subserving Social and Economic life, and alive.*—But because its roots are deep down in the social and the economic life of India, it leads a charmed life, denounced in theory but accepted in practice. Doomed to death but fated not to die, caste lives on. It lives on, not only because it ministers to the social and economic needs, if not vanities, of man in India, but also because it has ever been adapting itself slowly, gradually, if inevitably, to ever-varying demands of modern conditions of life.

Many-sided Variety.

21. 1. *Variety by Regionality.*—Variegated as is the indigenous culture by the double process of Isolation and Caste, it is quadrupled by geographical elements of each region. Hindu civilization retains, in the main, the features of its forest origin and nurture, though the forests have disappeared long since. This has been operated upon by the local geography of each considerable tract.

21. 2. *Desert Type.*—The thrifty habits of the Marwari and Multani and in recent times the Nattukottai Chettiars make them the money-lenders and financiers of India. Those habits derive from their desert homes of Malwa and Rajputana and Ramnad. Men of Jaipur, Jodhpur, Bikanir, Alwar, Shikarpur, Multan are spread all over India; and they it is that back Indian Trade and Industry, taking any risk.

21. 3. *Mountain Type.*—The Mahrattas from their emergence into history have proved on many a battlefield their indomitable courage; their ability to hold their own; and their capacity to hold together. The Great War in which they were recruited to the army after long lapse of time has shown that those qualities are not accidental but inherent in them as the gifts of their mountain home. Added to their courage is their skill in diplomacy and politics. Poona has been the nursery of statesmen, even in modern times. Ranade, Gokhale and Tilak are household names. One noteworthy feature is that the women of Maharashtra have been specially brave, accompanying their men-folk to battle and accepting with them death and glory.

21. 4. *River and Plains Type.*—River and plain have developed other types. The Bengalee is well-known for his intellect and his great heart is susceptible to just emotions. He has been a leaven of intellectual and social life wherever he has settled.

21. 5. *River, Plains and Desert Type.*—The Sindhi, also belonging to river and plain but under desert influence, is energetic, ubiquitous, venturing abroad if he can make a pile of

pice by bartering in the lion forests of East Africa or by hawking in the streets of Lancashire.

21. 6. *River, Plains and Mountain Type.*—Developed under river and plain and mountains, the Punjabi is strong of will and body and mans half the Indian Army.

21. 7. *Coastwise Plains Type.*—The dry coastwise districts of Madras send out the largest number of emigrants yearly; and the Plantations of the British Empire—of Natal, Malayan States and Tropical Islands from Trinidad to Fiji—owe their prosperity to the untiring labour, exceptional patience and frugal living of Madras Coolies.

21. 8. *Plateau Type.*—It is remarkable that men of inland plateaux are least disposed to go abroad while those of rivers and plains are best disposed, as seen in the case of the Sindhi and the Bengalee.

22. 1. *Homogeneity by Geography, The Bengalee.*—Another geographical result is seen in Bengal, where the land is a well-watered level plain scarcely rising to three hundred feet in three hundred miles from the Sea. The Bengalees, despite all differences of caste, creed and colour, are more homogeneous than others in India; possess widely diffused general culture and are highly responsive to modern impulses, thanks to their travel-sense and sociability, which are themselves induced by their Geography.

22. 2. *The Sindhi.*—Geographical influences have moulded a similar homogeneity in the riverine and desert plains of Sindh.

22. 3. *The Punjabi.*—Another region where the genius of the place makes people homogeneous in spite of themselves is the Punjab.

23. 1. *Individualism of Mountain-dwellers.*—The largest differences are observable among the Mountain and Forest folk, where each body of people clings tenaciously to its own, changing only when it must. They develop stern individuality.

23. 2. *Illustrations.*—Districts from Konkan to Orissa as well as Nepal and Coorg and N.-W.F. Province furnish illustrations.

24. 1. *Variety by Impacts from outside.*—This great variety in India due to all such causes has been increased, and not diminished, by the impact of cultures from outside.

25. 1. *Islam, a Great levelling influence.*—The Muslims of India are the largest in numbers of the Moslem world and among the most devout. Islam, moulded in the deserts of Arabia, strong with the strength of Central and Western Asia and sweet with the perfume of Persian Letters, has, for twelve centuries, been spreading its levelling influence in India.

25. 2. *Harijan Problem the least.*—It is a striking fact that the Harijan question is negligible in Sind and the Punjab, where Islam is prevalent, while it has remained a great question where Hinduism is strongest as in Kerala (Malabar).

25.3. *Regionality in non-religious matters.*—Yet in *non-religious* matters, there are regional differences. To cite only a few examples: The Moplahs of Arab descent inhabit the valleys of Malabar; they are peasants and traders and have retained their Arab qualities. The Muslims of Bombay and Sind hold a most commanding place in the trade and commerce of India. The Administrative talent of the Delhi and U.P. Muslim is generally acknowledged. Several of the Bombay Trading Muslims have the joint family system.

26.1. *Variety by Christianity.*—Christianity came to India early. The Syrian Christians of Malabar date from the first century A.D. But only when the Christian Powers of Europe came with the gunboat, first for trade and then for conquest, did proselytism commence on a large scale. The Inquisition worked at Goa and gusts of Christian zeal used to sweep over Pondicherry. The British kept aloof, letting their subjects live and worship their own way. They opened the door to the missionary only in the XIX century; and here too it is to be noted that the largest number of Indian Christians is in South India; and therein, in Malabar and contiguous districts, where Hinduism is strongest.

26.2. *Variety of their Denominations.*—All the varieties of Christianity are here in India (except the pre-Soviet Russian Church) with all their denominations.

26.3. *Variety of European Culture in India.*—And in other than religious matters, the genius loci establishes its influence, adding new varieties to the old. Apart from their religion, the Europeans have brought their modes of life, developed in the cold countries of the Eastern Atlantic seaboard. As observed before, they found the caste system in India and have fitted themselves into it, living apart in a world of their own, disdainful, it may be, and exclusive like caste-men. The variety among them, however, is not so much due to Indian Geography as to the Geography of their several homes; for, they have not settled in India so as to be subject to her influence.

26.4. *Variety by Parsis, etc.*—The Parsis, fleeing with their sacred fire before the Islamic sword of Arabia, have found Asylum in India for 1,200 years among the Tolerant Hindus; and they have enriched their new home beyond all proportion to their small numbers. They have retained their usages and added to the Variety of India. Others like the Jews and Armenians need no special mention.

27.1. *Variety by Sects, Jains and Buddhists.*—The Jains are an entirely indigenous sect marked out by the most delicate tenderness for life. We have passed by Buddhism, because Buddhism, born here, is invisible here. But Buddhism left the land of its birth not until it re-created and re-incarnated itself in India in Modern Hinduism, as in Congregational Worship in Temples; abstinence from meat; reverence for life, etc.

28. 1. *Variety by Food, etc. by Food Crops.*—The food of the people follows the lines of geographical distribution. Where ample water supply is available in summer, (even in N.-W.F. Province) rice is grown. It is *the* monsoonic crop and is the staple food of the Lower Gangetic Plains of Bengal, Behar, and Orissa; of Godaveri, Krishna and Cauveri deltas. Wheat requires less water and more cold and is grown in Central, Northern and Western India; being the staple food there. Ragi, taking much less water, is grown in Mysore. Millet takes up even lesser water; as Jowar and Bajra, it is food and fodder in the dry Inland Regions from South India to the Punjab. Barley, which stands much cold, is found in the U.P. and the Punjab. Of pulses, different kinds there are, suited to varieties of soil.

28. 2. *By Fodder Crops.*—In the pressure on land, the food-and-fodder crop is grown as double utility, for grain and straw, for man and beast. But the rural economy of many a place requires fodder being cultivated as such. Here, and in Hay-making, there is room for improvement.

28. 3. *By Oil-Seeds.*—Oil-seeds are grown following local variations of soil and climate, and enter into the dietary accordingly, each region selecting its own seeds. Malabar of the coastal plains uses cocoanut oil; ground-nut oil of the East Coast is displacing gingelly oil there; mustard oil is favoured by Bengal; and linseed oil by the C.P. and Guzerat.

28. 4. *By Meat.*—Meat is taboo to Jains and many Hindus; but even those who may eat it seldom can afford it. Sheep, goats, cattle and pigs are also reared for food. Over extensive tracts of land, there grow only thorny shrubs which no animals eat but goats, and which are fit for no other use. By the goats, they are converted into human values. India has therefore the largest number of goats.

28. 5. *By Milk, etc.*—Even those who do not take meat are by no means averse to milk and ghee. But their consumption is limited by the quantity available and the quality, which is seldom unadulterated.

28. 6. *By Fruits, etc.*—India is a land where fruits and nuts may be grown in tropical abundance, mango and jack; oranges, figs, and apples ; walnuts, almonds and cashew ; but the actual home demand, except in larger Towns, is too little.

29. 1. *The Indian Dietary.*—Examining Indian Dietary at Coonoor Research Station, Col. McCarrison has declared Wheat to be preferable to rice and that the Sikh diet of the Punjab is an ideal one—the diet of *ata roti* (unleavened bread of whole meal) with pulses, vegetables, ghee and milk (eked out by occasional meat). Other dietaries disclose deficiencies of one kind or other. But the greatest deficiency of all is the wherewithal to buy food.

30. 1. *Role of Pansupari, etc.*—To Hindu and Mahomedan alike, the pansupari is welcome; and it is still the symbolic

exchange of courtesies, friendliness and loyalties. There is a consensus in Northern India that pansupari and ghee-fried sweets are exceptions to mutually forbidden food.

31. 1. *Variety by Dress.*—While Geography makes available many a fabric for dress, climate makes the choice; and caste (in the extended sense) settles the shape, mode and style for every man, woman and child, departures from which are ruled eccentric or idiosyncratic. In India, dress is expressive also of the man's culture, caste, and place in society as well as his rank and wealth.

31. 2. *The 'Fur Coat'.*—Lord Morley once illustrated his opinion of the unsuitability for India of certain political institutions, by resembling them to fur coat for India. So wide is the range of climate that there are parts of India like the Alpine valleys of altitudinous mountains, where a fur-coat would be very welcome to several millions, affording them cosy comfort against cold.

31. 3. *The Fabric.*—India produces Wool, and Silk, and Cotton more than sufficient to clothe her population. Silk (coming at first from China, in Sanskrit the Chinamsuka) is the luxury of the richer. Wool is available for Northern Indian cold, but is costlier than cotton. The fabric most generally used is simple cotton cloth for the hot days and Padded cotton for the cold. To pass into or out of quilts (Razai in the North or Bonda in the South) is to express the seasonal change.

31. 4. *The Indian Cloth.*—Until eight decades ago, India produced cloth for export, meeting all local demands. Her looms were renowned the world over. The Kashmir Shawl, the Benares Lace-cloth, the Madura Sari are still sought after. But gone are the days of the Dacca Muslin and such other cloths of fame.

31. 5. *The Indian Customer of Cloth.*—It is however the patronage of the poor man for which compete Bombay and Ahmedabad, Manchester and Osaka. Here is a case where Geography provides the fabric and an immediate market for the cloth but the utilization of the one with the other is subject to political conditions and economic factors: the cotton market of Bombay being one of the best organized and most sensitive in the world.

31. 6. *Khadi.*—Khadi, or home-spun and home-woven cloth, apart from political significance, is intended to turn the idle time of the Indian millions into self-helping use.

32. 1. *Clothing and Poverty.*—The number of yards a man buys multiplied by their price is a fairly constant factor, showing the limitation of his means upon his desires. Favoured by the hot climate, and driven by necessity, the poor Indian goes about scantily clad. Gandhiji got into that, out of his longing to identify himself with the millions. A *langoti* (loin cloth) may be all a man's dress, in India: and *Sadhus* are known to

brave the winter half-naked on bleak Almorah's hill, by inuring their bodies to it.

33. 1. *Sari, Dhoti, Tailored goods.*—The seamless *Sari* for women, so colourful and so picturesque, is an Indian evolution and has not yet yielded place to western types; the seamless *Dhoti* is for men. The *lungi* is favoured by the Mussalmans who more than the Hindus use tailored clothes, which seem to be of ancient Persian origin.

33. 2. *Shawls.*—In the cold season, in tracts where sudden chills may be expected, Shawls are carried, slung from shoulders.

34. 1. *Indian Styles adopted in the world.*—In World Geography the Pyjamas, Jodhpurs and Banians have travelled from India to other countries; the *Solar* topee is an Indian adaptation of the hat, which, by the non-conducting pith of Sola plant, keeps off heat.

34. 2. *The Head-dress, the Turban.*—As observed above, dress varies from place to place and society to society; but in India, the head-dress of his apparel oft proclaims the man—and the local climate also. It varies from the Malayali and Bengali Nothing—which lets the oiled head reflect away the steaming heat—to the Fulness of the Punjabi Turban which rises, fold on fold, with tail behind, protecting the head and the nape of the neck from the fierce rays of the dry summer sun. Present a cloth to a field labourer in South India and he will tie it to his head as turban because of its protecting him from heat.

34. 3. *Generality of its use.*—The Turban used to be the article of dress common to all Indians; but in the last few decades the Fez cap distinguishes the Indian Moslem; and the hat is coming into vogue among English-educated Indians.

35. 1. *Variety by Colour.*—White colour reflects the heat falling upon it and black absorbs it; and accordingly, the favourite colour of dress in India is the white; while black remains unwanted; other colours lie betwixt and between.

35. 2. *Sense of Colour.*—The Indian woman has a delicate sense of colour; she chooses her sari to match her complexion; and India foots a colour-bill to Germany running into crores of rupees yearly.

35. 3. *Colour, as religious symbol.*—Two colours, the white and the saffron, have trailed from ancient times associations of Religious Symbolism. The white is expressive of ceremonial purity; and the saffron robe—its ground colour, of the earth, earthy—is the dress indicating neglect of material things, worn by those whose gaze is heavenward-turned (the Sanyasi, the Faqir).

36. 1. *Complexion.*—The skin is the first of dresses; and the Sun has pinched the Indian skin black and brown, whereby the Indian labourer is better fitted for outdoor work under the Indian Sun than the colourless man.

36. 2. *Bathing.*—Pains are taken to preserve the complexion as well as to help the skin to function best. To bathe in oil is a common thing in India; and daily bathing is prescribed by Hindu Law-givers and is observed by the Hindus in their tens of millions, even in biting cold.

37. 1. *Population.*—India contains some 36 crores, a sixth of the world's population, and bids fair to beat China in numbers.

37. 2. *Man Power of India helping British Commonwealth.*—This vast Man Power contributes to the strength and glory of the British Commonwealth and is ever drawn upon to supply British wants in men, whether for War or Peace—Ypres and Natal, for example, speak to that. At Ypres, the Indian army laid down the lives of its men, to stem the on-rushing tide of the German guns and gain time for the British to hurry up and form their lines behind. Palestine and German East Africa were won by the Indian Sepoy for the British. In Natal, the Indians have created paying gardens for British masters. It has been said that the Indian gardener, without whom many an Empire-country should lie waste, is an Imperial Asset costing but £2 an acre.

38. 1. *House and Geography.*—The Houses of *common* people reflect the climate of their locality. We have, for example, in regions of little rainfall, the flat mud roof (Anantapur, Baluchistan); of abundant rainfall, the gable (Malabar, Bengal); of snowfall, the steep slope (Himalayan Valleys); etc. Their variety and adaptation are striking.

39. 1. *Variety by Settlements.*—Two cities only are of over a million inhabitants. There are not forty towns with over 100,000 population; and not four hundred with over 20,000; while the villages number more than 700,000. It may, therefore, be said truly that India lives in her huts and cottages.

40. 1. *Village, the Unit of Indian Life.*—The village has been the unit of Indian life from time immemorial; and the Village community led its corporate life under its Panchayats (the Council of village elders). Thereby, it was enabled to survive the fire and sword to which it would be consigned. Scarcely would the despoiler depart when it would re-form and re-establish itself and resume its life.

40. 2. *Villages, strengthening Cultural Features.*—To the villages is due no small share of the stability of Indian Civilization and its Simplicity Their self-sufficiency and their diffuse scattering over the wide spaces of India proved their salvation. Here, then, is a geographical cause (apart from intrinsic worth) for the survival, the continuity, and the antiquity of Indian Civilization.

40. 3. *Decay of Villages.*—Rulers came and Rulers went, but no one could hurt them all at a time; and the villages went on

until very recent times, when internal decay began to set in and injure their vitality. The new forces of Modern India have contributed to the decay of villages, chief of which is the rise of towns.

40. 4. *The Indian's Village-Sense and Revival.*—Yet so strong is the sense of village among Indians that there is yearning to reconstruct it. That is one of the planks of the congress platform; and Wardha under Gandhiji is having a busy time of it.

41. 1. *The Town.*—The aggregation of Villages makes the Town (e.g. Palghat, Madras). Towns have sprung up in the past as capitals (e.g. Delhi—there are seven Delhis, in ruins); as Governor's seats (Lahore, Peshawar); as fortresses (Multan, Gwalior, Bharatpur); as Holy Places (Benares, Gaya, Amritsar); as way-nodes (Dera Ismail Khan, Bezwada); as sea-ports (Surat, Masulipatam, Calicut, Alleppey); as river-ports (Patna, Dacca); as market-towns (Hinganghat, Pollachi); as manufacturing-towns (Moradabad, Ludhiana); as camp-towns (Aurangabad), etc.

42. 1. *Variety in Sources of Power, Animal Power.*—The abundance of villages makes India take the leading place in animal husbandry. In the number of animals, their various kinds and their several uses, no other country comes near India.

42. 2. *Cattle.*—Cattle are the best used source of Power in India, next only to man. They are used to draw carts, plough fields, transport burden (they were mounts too, formerly), raise water from wells, press oil from seeds, and do many an other duty in rural and urban life. Through them, waste straw and grass become converted into power; while yielding also food, as milk to the Hindu, as meat to the Moslem.

42. 3. *Cattle, in History.*—What made Tippu Sultan so formidable in History was his mobility through cattle, in days when there were no railroads. Passing into British hands upon his fall, and annexed to the British Commissariat by Col. Wellesley (later, the Iron Duke), the Mysore cattle beat the Mahratta horse (at Assaye, 1803, etc.) finally. Even now, the army makes large use of cattle.

42. 4. *Other Animals.*—Elephants are tamed to man's service and they carry men, pile logs, draw guns. The camel, horse, mule and donkey have a regional distribution and use.

42. 5. *The Horse.*—But the horse, save for the army as at Hosur, Sargodha, and the canal colonies of India, is not bred for strength or quality; it does the humbler service of drawing ekkas, tongas, gharis and jutkas; and its endurance is as remarkable as in the Mahratta days.

43. 1. *Variety in Culture.*—Thus constituted and provided by Nature, India developed a level of civilization not behind that of other peoples of the world, from earliest times till XVII century.

The Cultural Lag, whereby the West is ahead of India.

44. 1. *The Cultural Lag.*—A definite Cultural Lag has supervened since XVIII century, Europe outstripping India with Modern Knowledge and Power.

44. 2. *Thereby Europe, ahead of India.*—The Grand Monarch, Louis XIV, may be compared with the Great Mogul, Aurangazeb; and the advantages are all in favour of the latter, save in the possession of loyal and able Generals, those of Louis creating and establishing the superiority of European Military Science and Service. That Superiority it was, which led eventually to the Supremacy of the British in India, who beat off their European rivals with their Command of the Sea. In the night that fell upon India in the XVIII century, the Mahratta held up the torch but contentedly dependent on borrowed helps (for example the French-trained Ibrahim Sahib Garde at Panipat, 1761, and French soldiers elsewhere) missed the real source of European Power—Creative Knowledge. In these three centuries, XVIII, XIX and XX, Science and the Industrial Revolution with all their consequences have wrought in Europe a wondrous sea-change into rich and great power; and all the while, India has been fast asleep. Even to-day the value of science and creative knowledge is dimly, if at all, realized in India.

Nature's Gifts to India; and Man's Use thereof.

45. 1. *Nature's Gifts to India, and Man's Use.*—We have seen how on the physical side, India is one of the countries best endowed by Nature; the gifts of her shape, situation and climate are an inexhaustible treasure. On the human side of utilizing them, men in India bring to bear their several gifts of knowledge, attainments, and varied culture; their caste (in the extended sense) creed and colour; their race and religion. And each takes his share of them in accordance with those dictates. Thus, the lucrative trade in hides and skins is a Hindu aversion but a Mohammedan occupation, though both the Hindu and the Mohammedan belong to the same place, say Vaniyambadi, and are at the same level of culture.

Even in this way Caste helps to diversify Indian Economic Life and to relieve pressure upon the same occupation in Static India, assuring its man a morsel of food and a chance to live, by learning his caste trade and plying it. Hence also the clash of competition in fields of shrinking opportunities, occupations being limited in a Statical India.

45. 2. *The Static Level.*—The India of to-day has reached its level, from statical standpoint.

PART II—DYNAMIC GEOGRAPHY OF INDIA.

Dynamic Geography, study of forces making change.

1. 1. *Dynamic Geography.*—It is the province of Dynamic Geography to make an estimate of the forces that are or will be in operation; synthetically to see things together, and as a whole; and indicate their tendencies in the future.

India linked to the World.

2. 1. *India's World Relations.*—To begin with, India's World Relations fall under two heads, the Political and Non-Political.

2. 2. *The Modern World consists of three Groups.*—Under the dread power of modern weapons forged by Science and the technicians, the modern World is divisible into only three groups: potential allies, enemies, and Neutrals. None dare act singly.

2. 3. *Alliances sought.*—Neither Mr. Churchill nor Chauvinists can dare to plunge the British Commonwealth into a Prestige-War, single-handed—catastrophe obviously waits on such an adventure. The British Commonwealth, too, has to seek Allies. Therefore, under modern conditions, what matters is, not so much what chinks in the armour there are, as what Alliances there are. Weak points in Defence are no more to be flung at India than at Britain.

2. 4. *India's Place in World Politics.*—India's place in World Politics is defined by her being part and parcel of the British Commonwealth. Its enemies are her enemies; its friends, her friends. Her King is the British King; her flag, the Union Jack; and she is under the protection of the British Navy and British Aircraft.

No Isolation except in World Politics.

3. 1. *Isolation in External Politics.*—It follows that the Principle of Isolation, which has been described to be at work *internally* in Static India, is carried to completeness *externally* in the sphere of foreign affairs. By India's place in the British Commonwealth, World events cast their shadows upon her, only indirectly, through the British connection.

3. 2. *Non-Isolation Elsewhere.*—But in Non-Political Spheres, the great changes in the World at large, wrought by the Discoveries and the Conquests of Science, alter completely the Geography of EACH MAN'S Environment, especially by annihilating vast distances in time and space. They batter down the walls of isolation, both Internal and External, in Non-Political Matters. No longer can India lead a sequestered life, shut behind secluding frontiers. The Indian has for neighbours not merely the cottages of his village or the town ten miles off but the wide world itself.

4. 1. *Remote Villages also linked to the World.*—By a Ford Bus, the remote villager can travel to his city a hundred miles away, transact business there, and return home by evening. To do so would have been an event of a lifetime before. And being where he is, he knows the prices current at distant Liverpool and remote New York within three hours of their settlement. The net result is, the villager is linked to the world. He may be in the heart of Vindhyan forests or Himalayan mountain valleys. The narrow grooves of his former being have crumbled down. The world comes to him where he is, and knocks at his door; and he now looks on the world as his neighbour. (See also para. 21. 2, *infra.*)

Caste adapting itself.

5. 1. *Caste also adapting itself.*—Like Isolation, Caste, too, has been feeling the impact; but such is its intrinsic vitality that it has been adapting itself to the varying demands of modernity. Not all the power of Clive could save a caste clerk from being outcasted for involuntary defilement by meat being thrust down his throat by soldiers in a prank. Two hundred years, and what changes! At the annual Oxford and Cambridge Dinners at Calcutta, it is not unusual to find Indians form 30 to 40 per cent. who retain, for all their residence for years abroad, their pride of place in their Society.

Self-Sufficiency breaking down.

6. 1. *Self-Sufficiency broken into.*—It is in Self-Sufficiency that the New Geography finds the largest inroads. Formerly, in the Villages, crops were raised for local consumption and life went on statically and at leisurely pace. Economic laws have brought more lands under the plough; crops are raised for cash more than ever before; new wants have sprung up; and the craving for comfort and amenities takes the place of the older contentment. (See also para. 21. 1, *infra.*) Migrations to towns are proceeding apace.

Towns and Cities, Centripetal.

7. 1. *Attractions of the Modern Town.*—The multiple and complex Personality of Modern Towns generates centripetal forces that deplete their Hinterland-Villages of their men of light and leading; and others go thither in search of employment. The Collector's *cutcherry*, the Police Thana, Courts of Justice, Schools, Colleges and Hospitals, the Shop and Factory, the Rise of the Professional classes, Theatres, Talkies and a hundred amenities of life, the wider chances of making a living (*fas et nefas*) or even of living on charity—all these modern causes act with compelling

force. The Linking of Villages to Towns and of Towns to Towns by Bus and Lorry has quickened the pace. Deserted villages are resulting from all such causes.

7. 2. *The Growth of Cities.*—The City rolls out before one's eyes as a place of life and movement. The modern cities of British making represent and reproduce the Western World in India and vitally influence the hinterland towns and villages.

7. 3. *Calcutta.*—The capital of India has been shifted from Calcutta to Delhi. Calcutta, owing its rise to the British and its importance to its geography, nevertheless, holds the first place in India not only as the city of palaces but as the city of capitals. Calcutta is the capital of tea, jute, coal, iron and steel, paper, and shipping; of Europeans in business; of Marwaris who are in all industries and finances; of University Developments; of Bengal Province; and of Bengalee Life itself.

7. 4. *Bombay.*—Bombay has the natural harbour that is nearest to Europe. Through the aspect of such situation, Bombay has risen from a small island to be the second city of India not through the wealth of its hinterland like Calcutta, but by the enterprise of its citizens; for, they include the leading trading castes of India (in the larger sense of caste). The Rajabai Tower in Bombay is adorned with figures representative of them and they are representative of Bombay. The Business-European, the Parsi, the Khojah Borah and Cutchi Memons, the Bania, the Bhatia, the Kathiawari, the Guzerati, etc., jostle with one another in the market-place and meet on equal terms at the Stock Exchange.

7. 5. *Madras.*—Madras is a congeries of villages that gathered round the Fort; and under its guns, secure from harm, it has grown by internal trade and external commerce. Its industrious and intelligent people provide officials, teachers, traders, clerks, coolies, etc. Its harbour, providing shelter on a surf-beaten shore and doing away with Madras Roads shows how the Spirit of Man (to wit, Sir Francis Spring, here) can transform Statical Geography.

Cultural Lag : universities, illiteracy.

8. 1. *Cultural Lag.*—There has been cultural lag. For three centuries, India has fallen behind. The leaven of new knowledge that leaveneth the whole lump of Europe has only recently begun to work in India.

8. 2. *The Universities.*—At the centres of knowledge—her Universities—until the end of the XIX century, the work in point of fact was only to produce men for jobs in Government service and the needs of administration, clerks and lawyers. They were merely external examining bodies, rigid replicas of the Mid-Victorian London. It is only through the genius and energy of the late Sir Ashutosh Mukherji and his work

at the Calcutta University (from 1904 to 1924) that Universities are prepared to accept the ideal of, and make some provision for, creating and re-creating Knowledge. As observed by (the first) Lord Haldane, Modern Germany and Modern Japan have been made at the Universities, the latter without even producing any outstanding geniuses. In India, we are only just at the beginning.

8. 3. *Illiteracy Drive.*—All European nations set great store by Literacy; and Japan, also, boasts 98% literates under the Meiji Scheme. In India 8% is the literacy. To liquidate illiteracy in the land is fraught with difficulties, both Geographical and financial. The population is scattered in villages over wide spaces and by long distances; they can be reached only with great difficulty by the Schoolmaster; he, too, is in need of a living wage in a capitalistic world unlike his forbears who taught, on the pial, letters to village brats, in return for doles of rice and pulses, oil and fuel. To spend yearly about Rs.100 only on a village for education is to find 7 crores of rupees yearly, for all. Other problems of health, sanitation, malaria etc., are in similar case, conditioned by magnitude and multitude.

Dynamic Geography emphasizes Progress, examples.

9. 1. *Dynamic Geography emphasizes Progress.*—The new Geography can emphasize how, armed with the strength and power of Modern Science, man in India can visibly raise the levels of Production and by fair distribution mitigate somewhat the appalling poverty of the people. What other countries have done with the weapons of Science, it is open to the Indian to do, for himself at least, if not for his country; for, even such self-regarding acts make Indian poverty by so much the less.

10. 1. *Illustration, the Old Geography of Japan.*—Statical Geography would describe Japan of eighty years ago as a typical Asiatic country—improgressive, unchanging, doubly isolated by being insular and by isolating herself, and lost in a mediæval dreamy life.

10. 2. *The New Geography of Japan.*—Dynamic Geography shows how the Spirit of Man has made her outdo her European and American teachers. Rudely awakened by Commodore Perry's knock at her gate (1853) she has roused herself from her age-long sleep and has grown into their formidable competitor in world markets. She illustrates how one and the same Asiatic nation, with Fifty Years of Europe, can pass by a Cycle of Cathay—at any rate, in material progress.

10. 3. *Japan, to-day, a maker of goods for India.*—Twenty-four years ago, Dinshaw Petit drew pointed attention to the singular fact that the Japanese ship in the Bombay Harbour unladed cotton goods and laded raw cotton. She buys pig iron and scrap iron from India and sells to India a hundred iron goods from pins to bicycles and galvanized iron-sheets.

11. 1. *New Opportunities opening in India.*—The bread that such occupations give could be secured for the Indian, were there available technical and scientific knowledge that is real and true and not merely Degree-ed, along with organizing ability and discipline.

12. 1. *Other such openings.*—We may give examples of similar opportunities in the dynamic Geography of India.

13. 1. *Agriculture.*—The tribute paid by Dr. Voelcker to the traditional skill of the Indian ryot holds good to this day. He leaves little room for improvement in his methods in crops within his range of experience. But in these fifty years since then, there have been other crops to the fore; more lands are under tillage; the available water supply changes; new cheap manures (like sulphate of ammonia, activated sludge and town-refuse) have come to supplement the old, while the quantities available of the old are a shrinking factor. The proportion of cash crops to food crops and fodder crops requires constant adjustment.

13. 2. *Sugarcane.*—The Wizard of the Sugarcane at Coimbatore (Sri Venkatraman) has produced a cane for every variety of soil, water, and sun, enriching the sugar content and advancing the bearing time. The work of that Burbank has not yet been availed of by Indians in general, though taken up eagerly, to their profit, by the Europeans in Sugar of Bihar and the U.P.

13. 3. *Utilization of Land.*—In statical geography, the utilization of land has been carried out as far as possible in ancient districts like Tanjore and Patna. But on the dynamical side, we see new opportunities and new uses springing up. New vistas open through new demands, and demands for more and better stuff; for kitchen gardens and flower-beds in the hinterland of growing towns; for groves of mangoes and cocoanut and jack; for fruit trees, nuts, and oil-seeds; etc. The canning industry has not even struck root.

13. 4. *Utilization of Gain; of Produce.*—And whatever is won from Nature is often lost to man through faulty storage and wasteful marketing.

13. 5. *Future.*—The New Geography visualizes improvements all round.

14. 1. *Fisheries, another illustration.*—Fisheries are another illustration pointed out by Dynamic Geography. Fish is not so widely consumed in India as it may be. But fish is a staple food of forty million population of well-watered Bengal. There and elsewhere, the demand can easily be made to create itself and whatever demand there may be, can be met entirely and cheaply, too, by the abundance of fish in Indian Rivers, Lakes, Ponds, Tanks and Seas. The trawlers of Japan (which is, like Bengal, a greatest consumer of fish) visit the Indian waters also, among other Seas of the world. Modern methods of preservation

of fish from the catch to the consumption, such as cold storage, ice-packing, keep the fish fresh for the table. The riches of Bengal are manifest on the subscription day of Government loans.

14. 2. *Fishery, utilization-Entrepreneur.*—Here then is a case where Geography can point to the potential development and utilization of the sea-acres and water-wastes; where all necessary factors are convergent. The utilization awaits the coming of an entrepreneur, preferably of Bengal, failing whom, of Britain or Bombay, who may soon take up the matter. Such a man (or a Company) can serve Calcutta with fresh fish from Chilka Lake brought in three hours of the catch by air-plane and reap the rich harvest of the sea. The non-utilization till now has always been a standing wonder to the Geographer.

15. 1. *Modern Transport an instance.*—Transport furnishes an instance where the opportunities are great and the problems are partly geographical, partly economical. Already, the Railways of India with their 41,000 miles of lines hold the third rank in the world though they do not yet make their own locomotives; and it can be expanded six-fold, so large a part of the country remains unserved by Railway.

16. 1. *Railways.*—Railways have created new life and culture where they traverse.

16. 2. *Railway in Andhra Country.*—The Andhra country throbs with new life, thanks to the East Coast Railway (now M.S.M. Ry.) connecting it with Calcutta and Madras in the last forty years, and thanks to the modern irrigation projects of the Godavari and Krishna Anicuts.

16. 3. *Railway and Kerala.*—Shut up between the mountain and the sea, Kerala, has been preserving many an ancient custom like the Hinduism of the Nambudris, the Impartible Joint Property (Tarwad) and its Laws of Descent. Before the Railway, the Malayalis used to lead a clean simple placid life with the simplest and best marriage laws in the world. The Railway has transformed completely their dress and manners, their outlook and life. Like Scotland, Kerala is the land of the mountain and the flood; like the Scotch, too, in education and thrift, the Malayalis have diffused all over India within the last forty years, thanks to the railway which has broken down their isolation.

16. 4. *Effect of no Railway.*—No Railway penetrates Nepal and Garhwal in the Central Himalayas, where Hinduism took refuge. Nestled in their mountain fastnesses, the Nepalees and the Garhwalis cherish their Independence and their Religion and preserve their customs unaltered. The Nilgiri Railway, on the other hand, has brought in Modernity and has seriously affected Toda (Mountain) culture, along with other causes.

17. 1. *Motors.*—In this century of Motor Car, Lorry, and Air-plane, the last has great scope in the great distances of

India, but will have only a weak development, unless Imperial necessities prescribe a large expansion. But the motor car and the lorry have been spreading phenomenally (thanks to Ford) and opening up the countryside and urbanizing the Villager's outlook.

17. 2. *Expansion.*—Less than 2 lakhs of motor vehicles are in India but even this number is to be checked so as to help up the falling Railway Revenue in which the State is interested. Unlike the case of flesh-drawn carts and waggons in Static India, the Railway and the Motor Car create their own traffic and swell its volume. The new opportunities are being fully availed of.

18. 1. *New Sources of Power.*—We have seen how Static India moves on Animal Power (Pt. I, 42. 1).

19. 1. *Coal.*—Coal has been found and used but the distances from the pit-heads of Giridih, Jharriah, Raniganj or Barakar are so great as to place it out of reach of many a place in India.

20. 1. *Water-Power.*—Water-Power, where available, makes up somewhat for that. By virtue of Relief, the waters of India in their journey from their source to the mouth, carry immense possibilities of generating Power. With every development of Hydro-Electrics in the world, more and more of Indian waters are harnessed.

20. 2. *The Cauvery.*—Cauvery Falls at Sivasamudram was the first place to be installed in India; the Cauvery itself has been made to yield still more power at Krishnasagar Dam higher up, and at Mettur Dam lower down; and there are other places higher up as in Coorg where the same river can generate more electricity.

20. 3. *The Pykara.*—The Pykara River on the Nilgiris has been dammed and electricity is supplied from it to many a District up and down.

20. 4. *Others utilizable in South India.*—Gersoppa, the highest falls in India, is about to be yoked. The Adab in Jeypore State in Ganjam (Orissa) can be put to similar use. With such 'white coal', South India makes up for want of Black Coal and can meet all her requirements in Power.

20. 5. *Power and Industries in Mysore, Model for Future.*—A series of correlated industries has sprung up in Mysore, an augury of things to come in India through or under State auspices. To work Kolar Gold Mines, the Cauvery Falls has been made to generate electricity, and Power transmitted on a 92-mile line (then the longest in the World). The Krishnaraja Sagar Project develops power also besides bringing water to a lakh of acres and a quarter. Still more Power is to be got from Gersoppa Falls. The Installations meet the urban and rural requirements in Power of Bangalore and Mysore and increasing circles of villages. What is remarkable is the correlated series of making electrical goods in Mysore State to cope with its electrical expansion;

porcelain cleats; electrical bulbs; glass (through Ogale); small electro-motor parts, etc. Forest Wood is treated for Posts and Pylons with Creosote obtained as by-product in the making of charcoal for the great Bhadravati Iron and Steel Works. Chemical industries are springing up for fuller utilization of by-products. Paper is made at Bhadravati. The Sugar Factory at Mandya is correlated with the sugarcane and the wet acres of Krishnaraja Sagar Dam. The near future may witness Mysore Aluminium and Mysore Silk built up by Science and not propped up by Tariff Walls.

21. 1. *Effect on life.*—Their effect on activities of life is striking. Already, in Mysore, Electricity in villages pumps water for irrigation, works rural industries; it lights the streets and the cottages, and runs the radio. Mysore is coming to every villager. With amenities thus provided and the Ruralization of Urban occupations, at the same time that town life is costly, the villager may after all stick to his village, resisting the spell cast upon him by Town. Here is a Harbinger of the Future.

21. 2. *Isolation outlook going out.*—The villager is rapidly losing not only his physical Isolation but the Isolation-Outlook. The old simple, self-sufficient and contented life of the village is enlarged and made fuller under modern conditions. Should this prevail, it may retard the Town-ward migrations of people.

World Progress ; and Disequilibrium.

22. 1. *Occupations.*—Occupations in static India have reached a stationary level. But in Dynamic Geography, they are subject to continual change. With every advance of knowledge and activity in the World, India cannot help undergoing corresponding changes.

22. 2. *World Progress—on Indian production.*—India furnishes the most striking examples of Dynamic Geography, in the consequences that have resulted to her Indigo, Sugar and Cotton, through the changes wrought by the spirit of man working upon matter. From early times until the nineties of the last century, Indigo was one of the principal sources of India's Wealth. The German Chemist in his laboratory learnt to produce cheap Aniline (Al+nil = The Indigo) colours from Coal Tar; and Germany has driven out Indian Indigo from the Indian market itself which now absorbs crores worth of German Dyes. Sugar Beet, also perfected by Germany, beats the richer yielding Sugarcane; Java, producing and marketing Cane-Sugar, supplies India, too, in part. Cotton goods come from abroad to India which, till 70 years ago, used to send them abroad.

22. 3. *Village artisans.*—As if there has been little change in the world, the old time artisans of the village—the carpenter, blacksmith, goldsmith, weaver, potter, etc.—ply their precarious craft with many, many ups and downs.

22. 4. *Industrial Revolution.*—The situation is like that which arose in England upon the establishment of Industrial Revolution. Large numbers in particular industries were thrown out of work but they were *re-absorbed* in the expansion of Workshops and Factories that followed the first burst, which took the world by surprise. On account of being the first, Britain became the workshop of the world. But the Unemployment due to one machine doing the work of tens of people fell upon the countries where the British marketed their output, of which India is one. The men thus thrown out of employment in India have not yet been re-absorbed in new occupations, as happened in England. The old occupations were gone and no new ones have taken their place. Even the expansion of factories in India has only increased, and not diminished, the process of throwing out the village spinner and weaver, so long as the factory output is only for the Indian Market. These remarks refer to the textiles in cotton and wool, which are the leading industries of India. The case is otherwise with other major industries—such as railway workshops; iron and steel works; leather and paper factories.

23. 1. *Industries.*—To meet the demands of the great market of India, Western modes of production are copied; factories have been established and are springing up for Textiles in Bombay, Ahmedabad, Sholapur, Cawnpur, Calcutta, Howrah, Coimbatore, Madras; Railway workshops in Bombay, Lahore, Jamalpur, Perambur, Golden Rock, Asansol; Iron works at Bhadravati and Jamshedpur; and so on. But these provide occupation for only a very small percentage of the population and not quite commensurate with its growth.

24. 1. *Cement.*—Cement is the first and only industry to achieve self-sufficiency for India, taking advantage of post-war conditions and making use of materials all of which abound in India. And it is sold cheaply, too, thanks to the competition of the Dalmias with the Dinshaw Combine (Oct. 1938).

25. 1. *Mines.*—Coal mining is ill-organized and not all of the mines are flourishing; but it employs many hands. Manganese ore is a principal export at Vizagapatam; Nellore and Hazaribagh mine mica; Gold-mining in Kolar, is a wholly European enterprise.

25. 2. *Tanning.*—The tanning of Hides and Skins is done as in the olden time (even at that, the oil-tanning has gone out of use). There is, therefore, a virgin field lying open in the making of High-Class Tanning and Finished Leather goods.

26. 1. *Flight of Capital into India.*—Under the Protectionist Policy of the Indians that are gaining Political Power, there may well be a flight of capital more than ever from Abroad into India, with her cheap and long-houred labour, despite sporadic strikes; *e.g.* Dunlop; Lux; Bata; Wimco; Imperial Tobacco.

26. 2. *Gandhiji's Emphasis on human values.*—The Gandhian epoch emphasizes the value of human things and would rescue man from being swamped by machine. But it has not made headway: the Factory is winning.

27. 1. *The Internal Trade.*—The internal trade of India is all-important. It is estimated at fifteen times the External trade and is capable of great expansion. It may be confidently expected that, with increasing facilities for Yields and of Transport, more occupations will be found and more mouths fed.

28. 1. *Agriculture.*—The chief occupations remain therefore centred round agriculture; more and more, there may develop dependent industries and engage many hands. The entrepreneur for them is yet to find his place. At the present time, the urban youth or the urbanized villager, willing to turn his hand to industry but disdaining rural toil, enterprises to produce urban goods as they may be called in India, soaps, candles, toilet articles, etc., in competition with Japan, Germany, France and England. Land finds no place in his thoughts.

28. 2. *Disequilibrium by Political action.*—Even in agriculture, world forces are at work that may disturb the disequilibrium still further. India pays England her dues not by selling all her goods to England but by selling to other countries of the world; and paying from out of such receipts. Economic Nationalism, Ottawa Preferences, Barter Systems and Tariff Walls have each its reaction upon Indian agriculture and prosperity.

28. 3. *Disequilibrium by New Producing-countries.*—Secondly, the produce monopolies (absolute and real, or virtual by reason of quantity) will be destroyed in the future. Already, jute has been successfully grown in Africa by Indians taken thither, and in a decade African jute will cut Bengal jute. Cotton is a necessity for War as well as Peace; and Soviet Ferghana under the Five-Year Plan yielding excellent cotton, has been linked to the Central Asian Railway and commands the West Asian markets, which were once supplied by Bombay. Italy is to raise cotton in Abyssinia and Germany pants for similar lands. British Africa has been growing cotton successfully.

28. 4. *Disequilibrium by new Production in India.*—Thirdly, the disequilibrium will be accelerated by large extensions of production in India herself. Among the great wheat and cotton areas are the snow-fed Punjab, and the rain-fed Central Provinces and Berars. Sind under Sukkur Barrage will yield within a decade wheat and cotton equal to those of Egypt in quality and quantity. That is bound to cause a great dislocation in India herself as well as foreign markets and the internal competition may push the precarious rain-fed C.P. and Berars to the wall.

Caste and Occupations.

29. 1. *Caste and Occupations.*—In Static India occupations have followed caste (in the larger sense); in the future, castes will follow occupations. The Great War has been a great solvent, and has forced the pace. Caste has fitted itself into the variety of occupations and into different parts of the same occupation and *vice versa.*

29. 2. *Specialized occupations.*—Since the division of occupations in India as a matter of fact has been by caste, each caste plays its specific part in Indian Economy as a whole. For example, the semi-nomadic Thoru caste do pioneer work, making clearances at the confines of the Terai; and cultivate the patches; upon such lands, other castes of settled life settle shortly after; and the Thoru leaving them goes farther into fresh Terai; and so on. A similar progression of castes happens at the Doab where the peneplains are extensive, 20 to 25 miles at places, and clothed with rank jungle vegetation. Likewise, in Bombay, the British may lead in the motor parts trade; the Parsi comes up followed by the Moslem and then by the caste Hindu; and finally comes the Marwari, with whom none can compete : he cuts his margin so fine.

29. 3. *Specialized even in the same caste.*—A man of one occupation will not take up that of another 'The palanquin bearer would not tie the calf'; 'The potter would not serve for barber'. Every European in India can speak to this from his own domestic service, where a servant of a certain designation will not do the duties of another—even though all may be of a caste and the work unskilled. (Cf. *Chhatri-ka-Naukar*—it is not within the bond for a servant engaged to bear umbrella to lift up a falling child).

29. 4. *Man finds his level.*—Thus in India a man, enabled to find his level, his occupation and his work, is at it with rigidity if he can, under caste-forming tendency.

29. 5. *Parsi creates new occupations.*—Turning to the casteless castes: Small in numbers, the great Parsi community has been pioneers of Industrial Progress, and latterly, of Finance. Their benefactions and munificence are well known. By their high education and traditional instincts of commerce, and freedom to go abroad, they have been the first to see the possibilities of new things and to seize the opportunity as Captains of Industry. They have been the pioneers of Mills in India, capturing the Levant and China market (both of which India has lost); of Western Hotels in India (the Taj Mahal Hotel); Iron Works in India (Jamshedpur); Aviation in India (Tata's); Cinemas (Madan); Safe-making (Godrej and Boyce), etc. Sir Jamshed Jeejeebhoy, the Jehangirs, the Tatas, the Petits, the Camas, the Wadias, Dadabhoy Naoroji, Sir Pherozeshah Mehta

and Wacha are but a few names out of those that have enriched India. The last three are household words in Indian Politics.

29. 6. *Parsi's Service to India.*—To find new occupations in Modern India, to show the way by their exertions and example and to be munificent with their earnings—that has been the service of the Parsis to India. No other community in India has covered itself with greater glory than this small Parsi community who claim no special privileges.

30. 1. *Selection by each Province made from British Examples.*—It is very remarkable that in the exchange of thoughts and ideas due to the British and Indians coming together, the attractions of each province have been to those aspects and sides of the British in India, which correspond to its own peculiar bent.

30. 2. *By Bombay.*—Bombay, devoted to Industries and Commerce, has been impressed with the British merchant, is close on his heels, and runs him hard.

30. 3. *By Mahrattas.*—The Mahratta, with memories of having been the last great Ruler of India, rises equal to the British in Diplomacy and Politics and the Art of Ruling.

30. 4. *By Madras.*—Madras, keen upon things intellectual, is impressed with the British Scholar and Ruler, and has turned out Scholars and Statesmen.

30. 5. *By Bengal.*—Dynamic Bengal, her thoughts and creative power turned upon politics, society and religion, has been impressed with British leaders of them, and has created New Faiths, and Modern Indian Politics and Society. Bengal is the laboratory of Politics in India and has given the lead in Science.

Such tendencies forcibly bring out Regional peculiarities.

30. 6. *By Railways.*—Likewise, the Railway Administrations, though run by the British, display similar regional differences.

Cultural Contacts.

31. 1. *Cultural Contacts.*—Geography and History show that different peoples cannot long live together side by side without their influencing one another in the several walks of life; only, the influence comes out visibly on the surface of each, according to its degrees of susceptibility.

31. 2. *Hindu and Moslem.*—The Moslem and the Hindu have been living for centuries not as two nations but alongside each other in the same town and village. The Moslems form part and parcel of the population; in all Indian affairs they play their part; have their say; and a weighty one at that. The influence of Islam on Indian culture has been notable, not only in Religion and Politics, but also in Painting and Architecture, in Social Manners and Customs, in Language and Literature.

32. 1. *Painting.*—Hindu and Buddhist Schools of Painting have been followed by the Rajput. And the Moslem School, at first deriving from Persia, shows an Indian evolution in strength of drawing and treatment of atmosphere and composition, as well as in differences of Symbolism and Realism. Amarendra Nath Tagore has founded the Bengal School while new schools are forming, guided by the Late E. B. Havel, Messrs. Percy Brown, Gladston Solomon, and Yazdani.

32. 2. *Architecture.*—In Architecture, the Hindu and the Buddhist have attained pre-eminence in Temple building which may be seen in the Geographical diffusions from Kabul (the pillar, Bamiyan) to Indo-China (Angkor-Vat); from Java (Borobudur, Prambanam) to Japan (the Toru, for example). And from the Hindu Kush, that influence has travelled Westward into Persia and Asia Minor.

32. 3. *Hindu Remains.*—In sculptures, and treatment of figures of animal and plant life and arabesques, in gates and pillars, towers, adornment of capitals of buildings, a continuity may be traced from Gandhara under Greek Influence to Mathura, Amaravati, Barhut, to the rock-caves of Ajanta and Ellora, the Raths of Mahabalipuram, the Chalukya bejewelled Star-pagodas, the Vijayanagar Temples and Towers.

32. 4. *Moslem Remains.*—Moslem Greatness is writ large in Sikandra and Fatehpur Sikri, the Taj Mahal and Pearl Mosque, Jumma Musjid of Delhi (and its cities in ruins) Badshahi Mosque of Lahore, Goli Gombaz of Bijapur, the forts of Agra and Delhi, the Kutub Minar, etc.

32. 5. *Blended Influences.*—The Indian Moslem buildings of India and Central Asia are interesting blends. Those of Agra and Delhi are modelled in grace and form, upon Samarkand and Bokhara, to which, the Great Timur took as his booty from India fifty thousand workmen from Delhi and through them adorned those cities.

32. 6. *British Buildings.*—British India, building under utilitarian philosophy of XIX century, has to its credit not these but Barracks, the Thana, Cooly Lines and Factory and the Cutcherry. The Victoria Memorial of Calcutta is Curzon's attempt to make up for the omission of ornamental buildings.

33. 1. *Dwelling Place.*—The evolution of the dwelling place, which, in the nature of things, responds definitely to regional geography, has not yet been studied and leaves a gap to be filled by geographers. The modern influence is everywhere visible not only in the wide choice of material but in the style itself; even so, there is a great uniformity in the hut and cottage, characteristic of places and regions.

33. 2. *Mitigation of Heat.*—It is very hot in the hot Season. The Seista, that noon-tide pause in the day's rhythm, is the common Indian's device against heat, save where he is in office

under the eye of the master. In building for habitation, it is a common design in India to have less light and more air; to have *cool currents* of air.

33. 3. *Mogul Palace.*—The Mogul in building his Palace designed it to mitigate the heat of the sun. The long wall to break the current of air; the garden; the water-channel and the playing fountain trained into the inner court, too, for inner apartments; the long verandah; the thick walls and double walls to retain the cooled air; and the Punkah to keep it in motion are his well-known devices.

33. 4. *British Bungalow.*—What was possible only to Princes has been available to the ordinary Britisher in India with whom the Solar Hat, the Lounge Chair and the Bungalow are associated. The Bungalow (so called after Bengal by the Portuguese) is built, so as to obtain cool currents of air, with long verandahs deep and cool, the air being passed through water-sprayed Khus-Khus curtains by the Punkah-puller (now being displaced by the Electric fan or Jost Fan). With the coming of air-conditioning, yet further stage is reached in comfort.

33. 5. *Town-Planning.*—Town-planning has a long history in India. Mohenjodaro of 3000 B.C. shows appreciation of Sanitary Science which in modern Europe dates from Chadwick's work in England in the forties of XIX century. The Town-planning of Conjeeveram and Srirangam, also indigenous evolutions, has received Dr. Patrick Geddes' esteem. Towns of Modern India are planned entirely by the British. New Delhi and Dacca (Ramna) are examples. Taxila and Nalanda are ancient university Towns whose ruins show thought and plan.

33. 6. *Modern Extensions of old Towns.*—Every old town provides itself with new Extensions on modern lines. Modern Mysore and Lucknow are beautiful extensions.

33. 7. *British Cantonment.*—While several old towns in Pre-British India are only tented camps made permanent, the British cantonment is a new feature; and the British segregate, and they build such towns as a series of Bungalows on long lines.

34. 1. *Difference: Britain and India.*—The difference between Chowringhee and Chitpur (both in Calcutta), said Tagore Babu once, is the difference between Britain and India, between the community service and outlook of the one and the other.

35. 1. *Society.*—In Social manners and customs, there has been an evolution of a common code of manners, graces and courtesies of life, which is commonly observed.

36. 1. *Non-religious matters.*—On the non-religious sides, Moslems and Hindus lead a common life in many places; a whole Treatise has been written of late by Dr. Hamid Ali, M.A., LL.D., Barrister, Madras, on the Non-Islamic usages in non-religious matters among certain Islamic folks in India.

37. 1. *Music.*—Music is an art where Moslems and Hindus have attained unity. The great Akbar himself used to be

enchanted by the divine art of Tan Sen. Indian airs and melodies soften the stern warriors of Afghan valleys and the Hindu Kush. South India has perfected a Music of Ragas and that is the common heritage of Telugus and Kannadigas, Tamils and Malayalees. North India has attained similar perfection.

37. 2. *British Music.*—In the sphere of music, the British have nothing in common with Indians. Under British influence, Orchestra is coming into vogue. British Bands play at Indian functions.

38. 1. *Hindustani.*—Hindustani developed as a medium for the intercourse of two armed camps (Urdu = camp, same as the word, Horde). The British also have contributed to its growth. Despite the controversies over vocabulary and script (though all the scripts are foreign to India), the language understood by the largest numbers in India has a great future.

38. 2. *Indian Literature.*—That Literature has both Hindu and Moslem writers; the late Sir Mahomed Iqbal was one of the foremost Poets. Although there are fifteen Indian literary languages, there is a large body of common thought and theme underlying them all. English Literature, acting upon Indian Languages, has made their modern Prose anew and given them modern outlook.

Indian's Reactions to British Types.

39. 1. *Indian Reactions to the British.*—The British and the Indians live apart in India; but there are mutual reactions all the same. Armoured in the triple brass of caste (in the larger sense) —Marriage, Food, and Occupations—the Indian may think himself untouched by foreign influences; but he has been responding to them, inwardly, all the while. The Britisher in India stays as Ruler but he is regarded also as the representative of multi-faceted and highly complex Western Civilization; and Western Ideas and Ideals have filtered to the untravelled Indian through one or other of such facets. To modernize after the European mode is, perhaps, a world impulse that is being witnessed from Istamboul to Samarkand; but the pulsations of new life in India are due to the symbiotic life with Britain.

39. 2. *Type to Type.*—Different types of the British have come to India and have created corresponding Indian types.

39. 3. *Ruler.*—The Ruling Briton, the I.C.S. and other officers, took up the then existing system of administration as moulded by Hindu, Moslem, and Mahratta, and made it efficient; so that in many districts, the courts, laws, and institutions are wholly British but administered by Indians entirely, without a drop of British Blood being found necessary.

39. 4. *Teacher.*—The early teachers of Letters and Science were British, and so well did they do their work that Macaulay, were he alive, would rejoice that his hopes were getting fulfilled

in that India could flaunt already five Fellows of the Royal Society and two persons crowned with Nobel Laureate (Tagore and Raman), an honour to which Asia from Turkey to Japan and Africa from Cape to Cairo have not been called as yet.

39. 5. *Soldier.*—The British N.C.O. has drilled the Indian Sepoy to equality with his British comrade in all respects except food, dress and pay.

39. 6. *Business-man.*—Setting up in business, the Britisher, though working for his own hand, has shown how to organize business, erect factories and run banks, build railroads and direct shipping; and the lessons of his success have been by no means lost upon vigilant Bombay in particular, and India in general.

39. 7. *Missionary.*—The British Missionary has stimulated Spiritual India to canalize its humane emotions so as to render acts of Social Service as practised in the West and adapt the ancient charity of India to such new modes.

39. 8. *The Professional.*—The British Doctor and Scientist, Engineer and Lawyer, successfully practising their lucrative professions in India, have set up high standards of *honour* as well as *efficiency*; and they are the accepted standard for their Indian brethren.

39. 9. *The Planter.*—The British Planter has triumphed against Nature; but the conditions of his success are beset with too many difficulties for Indians to follow, or compete with, him. The Epic of the Tea Garden has scarcely been told. To 'open out' a tea garden means to go out into the wild jungle, making a working team of heterogeneous hundreds of wild and aboriginal tribes and hillmen; to be remote for months from the Doctor and from civilized society of their own kind; and to take the risks of being cut off in one's prime by blackwater fever and other diseases which make no difference whatever between European and Indian. Here is a good example of Dynamic Geography showing what can be achieved under Modern conditions.

39. 10. *Companies.*—Great Companies like the Imperial Tobacco Co. show by their operations at Guntur how the land here may, by its being made to yield its best, sustain not only the ryot but a highly paid staff for technical skill and supervision. That is an object-lesson to India. Similarly, Spencer's at Dindigul famous for Cheroots. Such examples show what room there is for development in India even in agricultural industry.

40. 1. *Anglo-Indians.*—Anglo-Indians have also been an object-lesson. When Indians were not to be had, they were the Teachers, Higher Clerks, and Doctors and Nurses; and even now they prove their worth, by Discipline and Efficiency, as Police Sergeants, Telegraphists, Wireless Operators, and in Railway Service.

40. 2. *Other Europeans.*—Other Europeans have brought to bear the components of their civilization on Indian Life. Especially so are the Missionaries of Europe and America, and the Salvation Army.

40. 3. *German Technicians.*—And one of the greatest factors in building up Indian Industry today is that German Technicians are available, *ready to work* under Indians and to *teach* Indians, and make up, with their genuine technical knowledge and skill, the want of Indian Technicians and necessary knowledge, as at Bhadravati.

40. 4. *Kind of Westerners Received.*—In the XVIII Century, it was the Soldier of Fortune of the West (De Boigne, for example, the prototype of Major Gahagan) that was welcome; in XIX, it was the Businessman; in XX, the Technician of the West is in requisition. Each age chooses according to its needs.

41. 1. *British Institutions.*—The British have brought with them their Institutions to India.

41. 2. *Club, etc.*—Besides the Club, which is as distinctive as exclusive, there are Gymkhanas, Race-courses, Golf-links, Yacht-clubs, Regattas, Pig-sticking Clubs, Tent Clubs, etc.

41. 3. *Sports and Games: Hockey, Cricket, Soccer, etc.*—Sports and Games, and Exercises to keep a man fit, such, even, as are peculiarly British have gained ground among Indians. In Hockey, India with the Wizards of the stick (Dhyan Chand and Rup Singh) has beaten the rest of the World in successive Olympics. In Cricket, individual excellence has been attained though not as yet the team spirit (as the last Vizy Team to England showed when there was reversion to Indian conditions). In football, the Mohan Bagan is the Arsenal of India. In wrestling, Gama has an unbeaten record.

41. 4. *Indian exercises.*—Indigenous Akharas have receded, coming out only on Moharam or Ganapati Festival; though they, excelling especially with Indian clubs and Leijums and sticks, swords and Dhand, have been spoken of as highly efficient.

41. 5. *Indian Contribution.*—The Polo, the Chess, and indirectly the Cards, are India's contribution to the world. Old time amusements like Hawking and Falconry save Cock-fighting, are things of the past.

41. 6. *The Sporting Spirit.*—To play the game in the right sporting spirit is one of the hopeful and unifying agencies of the future.

41. 7. *Similarly Science is unifying.*—Education in Science, which recognizes no racial or commercial or even provincial or religious boundaries, is another cementing factor in New India.

41. 8. *Sports and Science.*—Sports and Science hold out great promise for India, bitten as she is all over with many a virulent poison.

Britisher's Reactions to India.

42. 1. *British Reaction to India.*—On the British side, Life is not without its tolls to pay. The only European in the heart of a forest, the Britisher goes through the rites of Tea-drinking as at Home, under dread of losing form. The Nabob of olden time, also under similar dread, drank his magnums and wore his broadcloth in broiling heat, at the same time as he adopted the Hubble-bubble and mulligatawny and (Becky Sharp's) green chilies. The Jos Sedleys and Touchwoods have gone, even the Colonels Mannering and Colonels Newcome. But in spite of cheap and frequent passage home, many a man has to sacrifice his Family Life and footing in English Society at the call of Imperial Service. He is, in the necessities of his position in India, further subject to the Twin process of Isolation so as not to be mixed up in Indian Society and of Caste in disdaining humble toil. There must be black sheep even in the white flock, and not all that came to India have been white. But on the whole, the white have outnumbered the black. The British differ from previous rulers in that they do not settle in India. Coming in relays in their prime, they flit about and retire in their middle age. India thereby suffers a double loss, loss of their Indian experience and loss of their example and leadership in the civic and political life of India.

43. 1. *Any Britisher 'Does'.*—It is a remarkable fact that any ordinary man of England could come to India and carry on, to the profit of both countries. The disparity between Mediævalism and Modernity, the Cultural Lag that still lies between, accounts for it but partly. It is the spiritual side of man to which that should be ascribed,—though they came for wages, worked for wages, and took their wages. A shoemaker, and a bookseller, an incomplete printer and a watchmaker (Carey, Marshman, Ward, Hare) urged by missionary zeal and Social Welfare Work, learnt and mastered Sanskrit, Persian, Hindustani, Bengali, wrote the grammar, provided these languages with the first printed literature, setting up Printing Press and cutting types learning that Trade, when they felt the need for it, by their own unaided efforts here (which they had not learnt at Home). South Indian languages owe a similar debt to foreign missionaries like Beschi, Fabricius, Rothler, Kittel, etc. Science is indebted to Roxburgh, Drury, Day. Ross and Haffkine have won world fame by their work in India. The Science of Modern Geography begins with Rennel's Hydrographic Survey of Indostan, more than 150 years ago.

43. 2. *Nicholson.*—Sir Frederick Nicholson, I.C.S. (Madras), was notably full of the Geography of the stations and districts of his charge from his salad years up. He was the author of 'Land Revenue Policy' issued by Lord Curzon's Government. As early as 1892, he foreshadowed Land Banks to cope

with Rural Debts. Upon retirement, he settled in Kotagiri and worked, harder than ever before, for Indian Ryots. His administrative experience stood him in good stead, and he looked to the business side as well. He was the father of the Co-operative Movement in India. He travelled to Japan for study; and had the Fisheries Department, Madras, constituted, to increase the available Food supply; and to produce fish guano and fish oil. He brought back also ideas on Elementary Education. He had the Kerala Soap Factory founded and the Canning factory established at Calicut and a factory for Jam at Coonoor for instructional purposes. His last efforts were directed to increasing fruit production, carrying on propaganda to exhort everyone to plant at least one fruit-tree a year. At the same time, he was doing his bit at the municipality. All this he did in his advancing years. He loved the land he lived in and worked in; and laid down his bones there. What a noble and inspiring record! Every province can show such salt of the earth.

43. 3. *Chatterton.*—Sir Alfred Chatterton could not rest content with the routine duties of Engineering service, Madras. He saw the room there was for the development of small industries and made Government do experimental work in Chrome Leather and Aluminium, and had these started, the first of any in India. He had the fly shuttle brought in to improve Handloom Weaving. Passing over to Mysore, he helped in the founding of Sandalwood Oil industry there. His career shows what one man with the Will can do, and make new openings, even when such things are not within his own skill or within his bond.

43. 4. *Hailey.*—Lord Hailey has stated how in the junior years of service he obtained a biggish farm to carry out agricultural experiments, at his own cost; and casting about for manager, secured the service of a retired Tashildar whose agricultural qualifications like his own were nil. But zeal and honesty more than made up for want of knowledge and Sargodha Farm served the Punjab as second only to Lyallpur.

43. 5. *Brayne, Calvert.*—The work of the Socrates in an Indian village at Gurgaon is watched all over India with interest. Sir Calvert has carved a name for himself in India by his work in Co-operative Societies in the Punjab.

43. 6. *Cotton, Cautley.*—By the genius of Sir Arthur Cotton and of Sir Proby Cautley, who had a geographical vision of Irrigation and started the Works, India has the largest system of Irrigation in the World.

Indian Examples.

44. 1. *Seshadri Ayyar.*—Happily, even in the field of Industry, there have been Indian Leaders. We may give a few examples. Rising from clerkship in Mysore to be its Dewan,

Sir Seshadri Ayyar, a born Engineer and man of action, electrified by the harnessing of the Niagara, at once set about picking his way through electrical knowledge; explored the Falls of Sivasamudram; and, in the teeth of expert opinion, installed the first Hydro-Electrical Works in India. His mind full of the dynamic geography of Mysore, he built the Marikanave Project and had many an other scheme to put through.

44. 2. *Visveswarayya.*—Sir Visveswarayya, a certificated Engineer, has to his credit Krishnaraja Sagar Project and Bhadravati Iron works. His bible is the Statesman's Year Book and the Abstracts of Indian Statistics. Best understood in U.S.A. and highly esteemed in Industrial Bombay, he has his plans of Reconstructing India and his latest work is to avert Mahanadi floods; and to make the Car in India.

44. 3. *J. N. Tata.*—India has not produced in the sixty years past a greater name in Industry and Patriotic Philanthropy than Sir J. N. Tata. His dynamical geography it was that gave him expansive thoughts. The story is told of how observing from the windows of his Railway Train the long lake at Sitabaldi, his swift mind seized on its potentialities; and he had the Empress Mills built at Nagpur, the largest textiles in India for many a long day. His mantle fell on Sir Dorab Tata and Sir Ratan Tata who have built Jamshedpur and the Tata Hydros, and pioneer Civil aviation.

44. 4. *Harkishen Lal.*—Opinions may be divided about the late Lala Harkishen Lal's misfortunes, but there can be no doubt about the service he rendered to the Punjab and Upper India. While eating his dinners in London, the dynamic Geography of the Punjab was always before his eyes. While there, he studied the Banking system of Germany and England; and on his return, he built up the People's Bank with moneys obtained on English banking system and Investments on the German model. He introduced Big Industries and Big Banking into the Punjab. Though his days ended in thunder-storms, the tribute paid to his work by the present Premier of the Punjab is as just as true.

44. 5. *Fazli Husain ; Ashu Babu ; Mehta ; etc.*—The late Sir Fazli Husain shares with the late Sir Pherozeshah Mehta and the late Sir Ashutosh Mukherji the fame of being Indians that combined in the highest degree executive talent with far-sighted statesmanship. Sir Syed Ahmed and Malaviyaji have created Universities. Indian Politics has produced leaders, such as Gokhale, Tilak, Das, the Nehrus, Gandhi, Azad and Jinnah.

44. 6. *Mookerjee ; Ganga Ram ; P. C. Ray.*—Romantic was the career of the late Sir R. N. Mookerjee of Bengal; as also of the late Sir Ganga Ram of Lahore; and Sir P. C. Ray among scientists, with the dedicated life of a Rishi of old, produces Chemicals and Chemists—both. Several of his pupils have filled the Science Congress Chair.

Room for Improvement.

45. 1. *Room for Improvement.*—A dispassionate examination from the standpoint of Dynamic Geography of India discloses that the Wealth of India in Agriculture, Forestry, Fishery, etc., may be multiplied and applied to the reduction of the Appalling Poverty of Indians. The more one observes and examines, the more one is confirmed in the belief that the Utilization of things in India is far from complete; that the disabilities are more human than physical.

45. 2. *Dayalbhag Experiment.*—Under the impulsion of religious background, the Dayalbhag colony produces marketable articles of excellence unobtained in India before (as certified to by Successive Viceroys). Here, Religion has put down the disturbing elements, furnished the cohesion and the discipline, and has ensured the quality. Religion has furnished the central authority—but all the same an authority that is obeyed.

45. 3. *Gandhiji's Khadi.*—Under the impulsion of Gandhiji's voice—the call to political as some say but humanitarian service as Gandhiji has it—Khadi has given a food value to idle hands, wasted hours, and hungry mouths, some millions in number.

45. 4. *Room for capitalist.*—What these do, the capitalist may do under proper conditions, although he may put out his money out of no philanthropic motive.

India in Transition ; Western Spirit ; some present difficulties.

46. 1. *Discordant elements holding together.*—For, the India of today is Nature's cauldron in which are gathered all the ingredients of a great civilization. The Hindu conserves the virtues of ancient civilization; the Muslim cherishes the glories of the Middle Ages; and the Britisher represents the power of the Modern Period. Varieties of races, religions, and cultures, caste and colour, as divergent as may be, are pent up within the Indian Frontiers. They live side by side, the lion by the lamb, in amity and peace. Such was the aspiration of the ancient sages (Siddhashrama) and such is the proud achievement of Pax Brittanica.

46. 2. *The Law of the Jungle.*—Discordant elements, and the hyenas of towns are, however, ever ready to break the King's Peace and set up the law of the jungle but the common sense of all keeps a constant vigil. There is nothing worth having, not even Peace, unless it is to be fought for.

46. 3. *India in Transition.*—India is in transition, passing from the old to the new; from the mediæval to the modern; from one culture to another. It is inevitable that in this period the divergences should be multitudinous and not harmoniously graded. The grotesque and the picturesque may be cheek by jowl; the incongruent, obtrusive; the contrasts and confusions, striking.

46. 4. *Old ties loosened.*—In this transitory period, the old ties have been dissolving (except for persistence of family life) and new ties have not yet been formed. Modern Western Life is conceived of as an emphasis on Individualism and Hedonism, each unto himself and each to put his own ease and comfort before other things, and drink life to the lees.

46. 5. *True Greatness of the West.*—Little understood is the fact—because it is not so apparent—that Western Civilization has its spiritual side, has its roots in Truth of Knowledge and Belief and in the principles of Self-Help and Self-Sacrifice, even though the Dedication be merely to Nationalism.

46. 6. *Deus ex machina for everything.*—Not seeing the West in its true light, Modern India may tend to look to *Deus ex machina,* always, for all things under the Sun. Accordingly, in the release from old bonds, the calls of Patriotism or of Nationalism, of Politics or of Religion, have a response but in varying degrees under the new conditions. Politics makes the largest appeal to the English-educated Indian.

46. 7. *Sects.*—Of course, there are, and will be, in India, as in any other country, persons exploiting the mob mind. Great Leaders have been springing up, obtaining large following; but the caste-forming spirit often makes each a sect.

46. 8. *Schisms.*—The fissiparous tendencies of Indian Life have been much noted, but even these seethings, breaking out on the surface as communal, provincial and linguistic jealousies and racial and religious antagonisms—those old familiar things—are but symptoms of *new* ferments at work making a *better* India.

CONCLUSION.

India has been awakening into Modernity through the Impact of Europe, the Connexion with Britain, and the Linkage with the World. The new forces permeate Cities and Towns; and, thanks to the Car and the Radio, they are penetrating Villages, where it is, that 80% of her teeming millions dwell. Of the leading features of Static India, Isolation is gone (save only in World Politics; and there it is complete); Self-Sufficiency is rudely shaken; Caste is responsively adapting itself; Cultural Lag alone has been slow to change, trailing, as it does, the Sense as well as the Memories of the Past. Even here, there is a stir of new life—this very Science Congress is a sign of it.

The leading agencies of the Metamorphosing now on, are both Foreign and Indian—Institutions, Societies, even Trading Companies; communities, individuals, and men of all occupations. The Human Elements are active while the Physical are fairly constant. The Future will be the Integration of all the Changes going on, both big and small.

The old Static Geography sees only the Pressure upon land, the Appalling Poverty, etc. of an Improgressive India. The new Dynamic Geography can see the forces at work, and disengage the true causes from the false. It finds that the causes are not inherent but removable; that man in India has fallen behind and is catching up: only, he has not, as yet, risen to the height of his opportunities.

At a given moment, geographical conditions are in equilibrium, but the equilibrium is of the Unstable kind. The Spirit of Man and its acquisition of strength through Creative Knowledge react upon his Place and his Work, bringing about constant change.

Here, in India, all the cultures of the World meet, in all their variety and range; and a great composite civilization is growing under the influence of them all. Therein will lie the diversity, richness, comprehensiveness and greatness of the Indian Civilization that is to be.

England is the Synthesis of Northern Europe, the United States is the Synthesis of All Europe. India is to be the Synthesis of the Whole World.

SECTION OF BOTANY

President:—K. D. Bagchee, D.Sc., D.I.C., F.N.I.

Presidential Address

INDIAN FOREST MYCOLOGY WITH SPECIAL REFERENCE TO FOREST PATHOLOGY

Even a casual acquaintance with our forests, vast and beautiful, extending all over the country between the Himalayas and the Cape Comorin, is sufficient to make one realize what a tremendous variety they represent—variety which no other single country of the world can produce in competition. And what beauty and wealth these forests embody! The gigantic pines and deodars and the graceful towering sals and teaks combine beauty with utility: they are the haunts of beauty, somber and grand, storehouses and reserve banks of valuable timber, supplying and holding for future use the luxuries and necessities of our civilized living, the silent, faithful guardians of our agriculture. But, what multifarious misfortunes they have to pass through to hold their own in the universe in the struggle for existence! Natural enemies lie in waiting for them in all the periods of life, from infancy to decay;—enemies like storms and fires, cankers and parasites, animals and human beings. If we desire to retain the picturesque grandeur and the enviable wealth of our country, it is imperative that we should aid these trees in their natural struggle. Like other precious objects these units of our beauty and prosperity also must be guarded with loving care, and our forests protected, expanded, and ably managed. These coffers of our treasure can be broken open for exploitation only as the last step, and in absence of any other alternative, when a national emergency arises, or when the trees pass on to a growthless stage of mature old age, necessitating replacement.

Among the natural enemies which undermine the health of forests are rusts and fungi causing disease and ugliness. It is pathetic to see an otherwise grand old specimen of deodar, with one side disfigured with 'witches' broom' and knotted branches. Perfect health is beauty and prosperity, and so work is to be carried out to combat disease. Today it is my privilege to acquaint my learned audience with the line of work followed with this end in view in the small mycological laboratory in the Forest Research Institute, Dehra Dun.

The investigations on various tree diseases and the problems associated with them can be divided under six main heads:—

I. *Coniferous rusts* which kill or weaken our coniferous spp. in the hills.
II. *Root-and-Stem-Rotting Fungi* which kill our coniferous spp. in the hills and hardwood spp. in the plains.
III. *Canker Pathogenes* which infest our native as well as some introduced hardwood spp.
IV. *Nursery Diseases* such as damping off, wilts, etc., against which controls have to be exercised in order to protect nursery stocks.
V. *Timber Diseases* which involve a detailed study of the characters of timber-rotting fungi.
VI. *The Ecology and the Habits of the Forest Fungi* which commonly grow on the floor of the forests or on the woody undergrowth or sub-aerial parts of the trees.

I. The investigations on the coniferous rusts were undertaken with two objects in view; namely, the protection of our young plantations of conifers from the ravages of parasites, and to determine the systematic position of various groups of heteroecious rusts so as to install them in the catalogue of European and Indian species.

There are actually fifteen coniferous rusts known to date (Appendix A) of which five are teleutoforms and seven aecidial forms (*Peridermiums*) on the stems. Moreover, because of the long range of the dissemination of these rusts, of the mingling of, three species of conifers, viz. *Cedrus deodara, Pinus excelsa* and *Picea morinda,* and of the merging of the *Pinus longifolia* into *Cedrus deodara* and *Pinus excelsa* in the natural regeneration, an arbitrary delimitation of the spore-disseminating area by field-work failed to meet the purpose of simplifying correlation with alternate hosts. These rusts are distributed everywhere from an elevation of 5,000 ft. to 9,000 ft. in the Himalayas, and therefore the probable broad-leaved hosts (Appendix B) have to be tested within this range with five needle-rusts before a successful matching can be expected; and even in case of negative results a large number of experiments have to be conducted to prove that the rusts are not related.

The occurrence of two teleutoforms (*Chrysomyxa deformans* (Diet.) Jaczew., and *Chrysomyxa picea* (Barclay) Sacc. and of two aecidial stages (*Peridermium thomsoni* (Berk) Cke. and *Peridermium piceæ* Barclay) on the same species *Picea-morinda,* and of another teleutostage on *Pinus excelsa,* have made matters very complicated because in the usual order of sequence the *Chrysomyxas* which really represent the teleutostages should have occurred on some dicotyledonous species, and only the aecidial stages, (*Peridermiums*) on the conifers. As Barclay (6) had expressed some doubt regarding the significance of these teleutoforms and of their relationship with the *Chrysomyxas* on one hand and the *Coleosporiums* on the other, side by side with the inoculation experiments, a cytological investigation on the Indian spp. of *Chrysomyxa* was conducted to find out the proper interpretation of these stages.

The biological relation of *Chrysomyxa himalensis* Barclay on *Rhododendron arboreum* has been definitely established with *Peridermium piceæ* (Barclay) Sacc. on *Picea morinda* by means of inoculation experiments; but the positions of *Chrysomyxa deformans* (Diet.) Jaczew., and *Chrysomyxa picea* Barclay both on *Picea-morinda*, and *Chrysomyxa* sp. on *Pinus excelsa* remain to be determined A careful search in the region for any new rust that might be correlated with these *Chrysomyxas* has not met with success; also repeated attempts to inoculate the cones of *Pinus excelsa, Cedrus deodara, Picea morinda* and *Abies pindrow* with the *Chrysomyxas* have failed The conclusion arrived at therefore, is that the three Indian *Chrysomyxas* occurring on conifers are apparently microcyclic, having abandoned the necessity of passing from one host to another to complete their life cycles.

Chrysomyxa deformans, one of the above three, has been definitely noticed to perenniate on spruce and to be reproduced from perennial mycelium every year, and it is highly probable that the remaining two might be behaving in much the same fashion though the actual method of their reproduction is not as yet quite clear.

Chrysomyxa himalensis Barclay which has been matched with *Peridermium piceæ* (Barclay) Sacc. produces the aecidial stage by direct infection on its coniferous host but where the latter is absent it perenniates on Rhododendron and develops teleutostage by perennial mycelium without the intervention of the aecidial stage. Uredostage is absent from the life cycle of this rust. It is apparently not so highly specialized as *Chrysomyxa deformans* and represents a transitional form between the truly heteroecious (macrocyclic) and microcyclic forms.

During recent years instances (1, 2, 3 and 11) have been reported from America of microcyclic fungi belonging to either *Coleosporium* or *Chrysomyxa*, in which only the teleutostage is present on conifers. The method of reproduction, has, however, not been stated.

On the other hand most of the Indian *Peridermiums* have been matched with their alternate forms (Appendix C), except *Peridermium thomsoni* (Berk) Cke., *Peridermium cedri* (Barclay) Sacc. *Peridermium* sp. near *cerebrum* on the stem, and *Peridermium* sp. on the needles of *Pinus khasya. Peridermium thomsoni* (Berk) Cke. may be related to *Chrysomyxa dietellii* Syd. as both occur in the higher ranges of the inner Himalayas, and a connection is likely to be established between *Peridermium* sp. near *cerebrum*, the only gall-forming coniferous rust in India, and some *Cronartium* on oak. These inferences are drawn from the fact that in the former case, *Peridermium piceæ* (Barclay) Sacc. has been matched with *Chrysomyxa himalensis* Barclay as stated above, and in the latter, from our knowledge of the relationship of the gall-forming coniferous rusts in America, namely, *Peridermium cerebrum* on *Pinus caribaea* and *Pinus taeda* with *Cronartium cerebrum* Hedge. on the *Quercus rubra* group (18). As for the *Peridermium* sp. on the needles of *Pinus khasya*, no suggestion can be offered at present, as the author has had no opportunity to visit the area in which it is known to occur.

Peridermium cedri or the deodar needle rust is one of our most serious problems, as it causes 'witches' broom', early defoliation, stunted growth, and die-back by perenniating in the host tissues. It is a widespread disease in the plantations and natural regenerations of deodar in Kumaon, Garhwal, Jaunsar, Simla Hills, Bashahr, Kulu and Kaghan forests, practically all over the Himalayas where deodar has its natural home. It has not been possible to correlate it with its alternate stage although no less than 20 different species of host plants bearing various heteroecious rusts of the family *Melampsoraceæ* have been tried.

The two remaining stem rusts on the conifers, namely, *Peridermium indicum* on *Pinus excelsa*, and *Peridermium himalayense* Bagchee (5) (*Cronartium himalayense* Bagchee) on *Pinus longifolia* have already been correlated. As these rusts have a definite area of distribution, work on them has been easier.

So far it has been a straightforward process to work out the biology of the various coniferous rusts and to attempt to place them in their proper generic group after their alternate stages on the broad-leaved species have been established, but it becomes difficult when they have to be fitted into the catalogue of rusts with reference to the European and American spp. When the hosts are the same, specially the broad-leaved ones, and the spore measurements and the morphological details agree in a wider sense, the naming of the Indian rusts is a simple matter, as the European or American name can be retained as a matter of priority. If there is some physiological difference accompanied by some slight morphological variation, it can be interpreted as the characteristic of the physiologic form; but when the hosts belong to different species, as they usually do in the two different continents, the problem becomes far from an easy one. It is true that biometric methods can be applied to arrive at some solution; but should they be the sole criterion while the physiological factors are left entirely in the background?

Let us take the examples of the three coniferous rusts, namely, *Peridermium indicum* Colley and Taylor, *Peridermium brevius* (Barclay) Sacc. and *Peridermium orientale* Cke., as their life history has now been worked out. Facts relating to the biology, morphology and distribution of the first of these, that is, *Peridermium indicum* Colley and Taylor, and *Cronartium ribicola* Fischr. may be summarized as follows:

(i) *Cronartium ribicola* Fischr. occurs in Gulmarg, Kashmir, on *Ribes occidentale* (4) and its aecidial stage (*Peridermium indicum* Colley and Taylor) on *Pinus excelsa.*

(ii) This aecidial stage when cultured on *Ribes rubrum* at Chakrata, U.P., produced uredo and teleutostages which are identical in all respects with the *Cronartium ribicola* Fischr. of European and American type though the sori are slightly smaller.

(iii) An aecidial stage on *Pinus excelsa* discovered in Kulu, Panjab, has been found under biometric comparison to be different from *Cronartium ribicola* Fischr. (*Peridermium strobi* on *Pinus storbus*) of Europe and America, and has been named *Peridermium indicum* Colley and Taylor (10). This *Peridermium* is very common all over the Himalayas and has been biologically connected with a *Cronartium* sp. on *Ribes rubrum* which is the same in all morphological details as the teleutostage reproduced from the aecidium from Gulmarg, Kashmir.

(iv) *Ribes rubrum* is one of the susceptible hosts of *Cronartium ribicola* in Germany and America and this teleutostage when used on *Pinus excelsa* (raised from Indian seeds) in those countries has reproduced *Peridermium strobi* (19, 20 and 23).

(v) In all other aspects and in almost every detail of the life history this rust which has been described as *Peridermium indicum* agrees with and behaves like *Cronartium ribicola* Fischr. of Europe and America.

In view of the above facts the proposition before us is that either relying on biometric methods we should retain the name of the Indian blue-pine rust as *Peridermium indicum* Colley and Taylor (10) and call the alternate stage on *Ribes rubrum* a new sp. of *Cronartium* (*Cronartium indicum*), or taking the life history and the physiological facts into account but leaving out the small morphological difference, we should call it *Cronartium ribicola* Fischr. or *Cronartium ribicola* Fischr. var. *indicum* (physiologic form).

Peridermium brevius (Barclay) Sacc., the second in the list, has been found to be the aecidial stage of *Coleosporium* sp. (*Coleosporium barclayense* nov. sp.) on *Senecio rufinervis.* There is another *Coleosporium* on *Senecio alata* which is morphologically almost identical with that on *Senecio rufinervis* though biologically it is quite different. Moreover, there is also a third species of *Coleosporium* occurring in the same locality on *Senecio* *chrysanthemoides* and *Senecio graciliflorus*, which is both morphologically and biologically different from the two forms mentioned before.

Recently, a rust on *Senecio* sp. has been described as *Coleosporium senecionis* Fr. by Sydow and Mitter (22) from specimens originally collected from Naini Tal. A portion of this collection, kindly supplied to us by Sydow, has rendered possible the identification of the host as *Senecio graciliflorus* and the rust on it (a uredostage) appears to be identical with that on *S. chrysanthemoides* and *S. graciliflorus* which the writer has collected from Chakrata.

Peridermium orientale Cke. on *Pinus longifolia* which is our third example, has been correlated with *Coleosporium* sp. on *Campanula colorata*. This species of *Coleosporium* had been previously considered to be identical with the European *Coleosporium campanulæ* (Pers.) Lev. and so the name was retained by Barclay (6). But the aecidial stage of the European rust occurs on *Pinus resinosa* which belongs to the two-needle group; whileas *Pinus longifolia* on which it occurs in India, is a three-needle pine. The alternate host, *Campanula colorata*, is also different from the European sp. of *Campanula*.

Again, the rusts on two species of *Campanula* in India (*Campanula colorata* and *Campanula canescens*), are biologically different. Morphologically also, there is a difference in the sizes of the uredo and teleutospores of the two Indian forms, which is the same as the difference between the Indian and the European or American species, and a biometric comparison is likely to prove the two Indian forms also to be different species. The physiological difference can similarly be worked out and the identity of the two forms established by cultural tests, that is, inoculating and cross-inoculating three spore-forms (aecidio, uredo and teleuto) on the two sets of hosts, coniferous and broad-leaved, of both the continents. But this process has several difficulties in its way and is not practicable.

In a recent publication Hiratsuka (13) has described *Coleosporium campanula* on *Adenophora verticillata* var. *typica* (*Campanulaceæ*) and produced the aecidialstage on *Pinus densiflora* and *P. thunbergia* by inoculating with this *Coleosporium*. In Europe, as already referred to above, *Coleosporium campanula* occurs on various species of *Campanula* and pines which are quite different from the Japanese hosts. It therefore appears to be difficult to call the European and Japanese species as identical without conducting a biological experiment with Japanese rusts on European hosts and *vice versa*.

Peridermium abies-pindrowensis nov. sp., which has been matched with an *Uredinopsis* sp. on *Lastrea Felix-mas* is another instance parallel with those just described. There are many other rusts belonging to the *Melampsoraceæ* and *Pucciniaceæ* groups which stand more or less in the same position but need not be mentioned here.

Taking all these facts into consideration it seems reasonable that these names may be regarded as only provisional, pending their final naming when they are definitely correlated. We know that in Europe the units of the form-genera known as the *Peridermium*, *Aecidium*, etc., are fast disappearing as they are matched with their alternate hosts. Similarly in India also, steps must be taken to catalogue them correctly as soon as they are correlated.

This, I believe, is a suitable occasion to point out that the International Rules of Botanical Nomenclature, 1935, provide for the identification of *Uredinales* from the 'teleutostage or its equivalent' (Art. 57, p. 17) and experienced uredinologists have found the words 'teleutostage or its equivalent' very convenient in this respect. Recently Sydow (21 and 22) has named two new *Coleosporiums* from the uredostage only and Arthur and Cummins (4) have described a new *Gymnosporangium* from the aecidial stage without having the advantage of examining the teleuto forms.

Before ending my discussion on coniferous rusts, I would like to take this opportunity of mentioning that in the ten years of work, the cytology of hitherto unknown or incompletely known genera such as *Pucciniostele*, *Phakopsora*, *Melampsordium*, *Chnoopsora*, *Nyssopsora*, *Uredinopsis*, and *Hyalopsora* has been worked out. This has been interesting work, inasmuch as the line of investigation threw some new light upon the generic grouping of the *Melampsoraceæ* which particularly cover all our heteroecious rusts which have the teleutostage on the dicotyledonous species. The cytology of wood-inhabiting rusts which was followed in detail to work out the pathogenicity problems, also appeared interesting.

From a purely systematic point of view, our list of heteroecious rusts has been enlarged by the addition of eight new spp. of *Coleosporiums* to the list (8 and 19) of eleven, five of *Phakopsoras* to two already known, three of *Melampsoridiums* to one species known, two of *Uredinopsis* to nil, two of *Milesias* to nil, four of *Hyalopsoras* to nil and one of *Nyssopsora* to nil besides a number of others such as *Puccinias*, *Uromyces*, etc., hitherto unrecorded. The biology of some of the *Puccinias*, *Uromyces*, and *Melampsoras* has been worked out, thus clearing the position of a number of unclassified aecidiums, the list of which is too long to be gone through in detail.

II. Now let us consider the item next on the list, that has engaged our attention for several years and which still continues to be of great importance, viz. the root-and-stem-rotting fungi.

When on a diseased tree the cause of the rot is attributed to fungus and the disease has passed the initial stage, it is natural to expect the sporophores of the causal organism to be associated with the rot. But if the rot has gone too far, the organism is likely to be eclipsed or overgrown with one or many secondary organisms which find it easier to grow on the medium already prepared by the active, delignifying wood-rotting agent. The sporophores of the parasites are likely to be discovered only in the early stages when the tree is just dying; from the trees that are long dead the primary pathogenes generally disappear in course of time, and it is only from the symptoms and available past history that the rot can be traced to fungal infection.

In other cases even when the rot is of fungal origin, no fruit-body or sporophore can be found. The sporophores are produced only when the conditions of light, temperature, and moisture are favourable and the wood has rotted sufficiently to supply the required nutrient for the reproduction of the ultimate organ of the fungus. It also happens that when the food supply in the medium is exhausted or restricted, the fruit-body of the fungus is produced. The relation between the degree of decomposition of the wood and the production of the sporophores is very difficult to establish and requires more research.

Sometimes the rot is the result of the combined action of fungi and bacteria as can be seen in the case of *gauj* disease of sal of the U.P. Terai (9). The core of the tree is decomposed in places and hollow cavities are produced, the tissues of the inner sides of which take a dark colour due to the action of fungi and bacteria.

The list of the fungus pathogenes causing disease, rot, or unsoundness of various important trees of our forests is a long one, but I shall restrict myself to those with which we are seriously concerned at present (Appendix D). They are mostly *Polyporaceæ*, popularly known as the bracket-fungi, but some are also *Agaricineæ*, or the toadstool fungi.

The sporophores of the first two fungi mentioned, namely, *Ganoderma lucidum* and *Polyporus gilvus* are always associated with dead and dying trees of various families including the conifers on the hills, and so they were supposed to be primary parasites. Inoculation experiments conducted on shisham, rosewood and Indian mahogany (*Pterocarpus marsupium*), on which they are frequently found, have, however, failed to prove this theory. The parasitic nature and the rôle which *Ganoderma lucidum* and *Polyporus gilvus* play on other hosts have yet to be proved by inoculation experiments. *Ganoderma lucidum* has recently been reported to be a wound-parasite on areca and cocoanut palms and inoculation experiments also seem to have proved this (25).

The mortality of shisham deserves a special mention here. It is definitely due to root disease and there is a high rate of mortality in the shisham forests of U.P. Terai and the Panjab plantations. Trees of all ages from saplings to fully grown ones are affected with equal intensity. It forms a striking phenomenon in the U.P., unique in the annals of the diseases of trees except perhaps the elm wilt due to *Cephalosporium* in America (12). *Ganoderma lucidum* and *Polyporus gilvus* have been invariably found at the base of dead or dying trees as already mentioned above, but they play only a secondary part. The primary organism is a *Fusarium* sp. which is known to cause wilt disease in several leguminous and other agricultural crop but this is the first instance where a forest tree is known to be attacked. Inoculation with pure cultures of *Fusarium* sp. under controlled conditions both in ground and in pot, have definitely produced typical wilt in shisham in India. *Fusarium* sp. has also been isolated from the roots of dying *Acacia catechu*, though *Ganoderma lucidum* appears at a later stage. There are other instances of association of the *Deuteromycetes* and *Ascomycetes* with the *Basidiomycetes* in causing root and collar rot or canker diseases, which appear to be not merely chance incidence but significant phenomena in connection with our tropical tree diseases. Only future research on the nature of the association can substantiate this hypothesis.

Ganoderma applanatum is another fungus which is believed to be a wound parasite causing heart-rot in toon, siris, mulberry and other forest trees, and although circumstantial evidence appears to be in favour of its parasitism there is no experimental proof to support it. Humphrey and Leus (16) have collected a good deal of information on this subject and have cited Hubert (17) who has recorded this fungus on *Acer negundo* in association with a *Fusarium*, thus pointing out this form of association once again. The literature on the subject has recently been summarized by Weindling (27).

Fusariosis of other Indian timber trees such as mahogany, teak, *Erythrina*, etc. has recently been reported from different parts of India. The damage caused by this fungus may be much more extensive than appears to be at present and as our knowledge of the various root-rotting pathogenes increases the extent of damage caused by *Fusarium* may be fully measured.

The most important of the fungi infecting *Shorea robusta* or the sal trees are:—

(*a*) *Polyporus shoreae* producing the partridge-wood type of rot on the collar region and the roots, (*b*) *Trametes incerta* producing spongy brown heart-rot of the stem, apparently the *gauj* of U.P. forests, (*c*) *Fomes tricolor* causing an extensive sap-and-heart-rot of sal, and producing at the early stage a pocket rot of sapwood which extends to the heartwood as a brown zoned-rot, (*d*) *Fomes lamaoensis* producing the speckled brown and cream coloured honeycombed-rot of stem, (*e*) *Fomes melanoporus* producing dark brown or brownish-grey rot of stem, (*f*) *Fomes fastuosus* apparently a wound parasite, producing a brown rot on the collar and exposed roots of sal, and lastly, (*g*) the rot locally known as Basanti or pox, because the fungus which attacks the heartwood of the tree frequently emerges to the surface having an appearance of small brown wedges driven into the wood, and consisting of pseudo-sclerotia. There are others, causing minor damages of wood, both heart and sap, such as *Polystictus tabacinus*, *Lentinus praerigidus*, *Schizophyllum commune*, etc.

(*a*) *Polyporus shoreae* is a root rot fungus which attacks the living bark, cambium and sapwood, these being the tissues which constitute the living elements of the plant body. The fungus, by killing the root, gradually reduces the absorbing system. As an active heart-rot, it weakens the anchorage so that the tree becomes an easy victim to storms.

The progress of *Polyporus shoreae* in the heartwood is very slow, but its function as an active rot is surprisingly lasting. On the stumps of the infected trees the fungus remains in active condition for years as long as there is a piece of sound wood left. The fungus appears to die out only when all the lignified element of heartwood is reduced to a dry and crumbling mass.

The behaviour of *Polyporus shoreae* on felled timber is not like a saprophyte in the sense of the term used in the text books of mycology. Also it is not a dry rot fungus, just because it decomposes dead and woody tissues to a crumbling mass, as our conception of dry rot is entirely different. It is a facultative pathogene and an active timber rot, a potential menace to our sal trees alive or dead.

It has been remarked that *Polyporus shoreae* is a rot that attacks the overmature heartwood; but it is a wrong notion. The sporophores are generally found at the base of a mature tree, but this does not signify that the fungus attacks only mature trees. Even young plantations 20 years old have been noticed to be heavily infected with *Polyporus shoreae*.

(*b*) *Trametes incerta* on the other hand produces a brown or greyish-brown spongy heart-rot of the stem, and like its cousin *Trametes pini* on the conifers, the sporophores or the brackets appear on the broken branch stumps when the rot has progressed very far. The fungus works from top downwards, the sporophores appearing at various heights usually about ten to twelve feet from the ground, and spreading upwards to the crown if at all the crown remains. The damage caused by this fungus contributes the largest share in the loss of young trees up to 3 feet in girth of quality IV and V, of Conversion and Hill Working Circles of Bihar forests. All the other causes combined including all other fungi and other agencies, do not cause more loss than what this fungus does singlehanded.

(*c*) *Fomes tricolor* produces a different type of rot on the sap and heartwood of sal. It is generally a saprophyte growing on the external and dead bark, but it also produces a brown pocket-rot on the sapwood of weak and unhealthy poles growing in unfavourable conditions. When the fungus attacks the external heartwood it produces on it a brown rot with zone lines. Some further study of this rot and the fungus concerned is highly desirable in view of the fact that this rot occurs all over Bengal and Bihar forests.

(*d*) *Fomes lamaoensis* is again a different type of fungus-producing rot. It starts from the dead sapwood of sal, only after the tree has been killed by *Polyporus shoreae* or by other agencies, and the bark and sapwood have become dry. The rot appears speckled light-brown at the beginning, and the wood becomes honeycombed, i.e. pockets are formed with thin layers or paper-like walls of wood. The fungus appears to enter through dead scars. Unlike *Polyporus shoreae* and *Trametes incerta* its activity starts from the outer layers of wood and the rot progresses deeper towards the heartwood. The sporophores appear everywhere on the stem from the ground up to any height, and the wood passes to an advanced stage of disintegration. The fungus is highly important in the pathology of sal.

(*e*) *Fomes melanoporus* generally attacks the collar region and it is usually associated with the occurrence of conspicuous elongated wounds or cankers. The rot which is dark-brown in colour and resembles the 'partridge-wood rot' with which it is often mistaken, works upwards to 3 to 4 ft., and in some cases even up to 8 to 10 ft. on mature trees, thus ruining the most valuable length of the trunk. On fallen logs the fungus functions as a heart-rot causing extensive decay, and alternate bands of sound and decomposed wood represent a characteristic feature. The sporophores which are dark-brown in colour appear on the stem where there is a connection between the outer atmosphere and the inner rot, established mostly through the borer-holes or knots of dead epicormic shoots.

(*f*) *Fomes fastuous* also, like *F. melanoporus*, appears to be a wound parasite producing a dark-brown heart-rot. The sporophores appear sometimes on the exposed roots, but generally on the collar region of poles and advanced trees.

From the above it is apparent that sal diseases in different parts of the forests are due to different organisms helped by various predisposing causes. The three important factors which have to be contended with are frost, drought and bad soil-æration or soil-condition. It is natural to suppose that any of these may upset the balance and pave the way for fungal attack. The unsoundness of sal can also be referred to the various ecological types of sal and may be grouped accordingly; for instance, the root-rot disease of sal due to *Polyporus shoreae* and the Basanti or pox-rot are prevalent amongst the best quality sal, where there is a good, rich and deep soil and excess of moisture, that is, in the low level sal area of Bengal and in the valley type of sal of Singhbhoom; the hollow stem-rot disease due to *Trametes incerta* has most of its victims amongst the dry region or highland type (poorer quality) sal in Bihar and U.P. forests; in the sharp and depressed valleys and along the frost-holes of Bihar and U.P. the *gauj* type of unsoundness is more common. It is not possible to analyse the various kinds of diseases of sal in this limited space and time, nor do we take it for granted that everything is known about them. It is naturally one of the most difficult problems in the history of Indian tree diseases and has to be handled with great care and caution. Researches are in progress and factors concerned with the disease and unsoundness of sal are under investigation.

Fomes badius Berk (*Fomes pappianus* Bres.) is a destructive fungus to babul (*Acacia arabica*) (24), khair (*Acacia catechu*) and *Acacia eburnea* (*Acacia cambelli*) in Berar, C.P. and Etawah, U.P. The babul which is one of the most important trees in the drier parts of India and has a gregarious habit, grows very well all over the black cotton soil and if the cultivation is stopped for a few years the land would grow into a pure babul forest had it not been for this fungus which runs riot amongst the babul. It is probably a wound parasite and produces a heart-rot of stem which spreads into the roots. The pathology, life history and the method of propagation of this fungus remains obscure.

The root-rotting and stem-rotting organisms affecting conifers in India have been a subject of controversy (7 and 14). They were taken up in connection with the severe mortality of spruce in the Jaunsar forests. There are two organisms generally associated with the rot, namely, *Fomes annosus* and *Armillaria mellea*. It was held that *Armillaria mellea* was responsible for the mortality and *Fomes annosus*, being a saprophyte, appeared after the tree had been killed by *Armillaria mellea*. The other view stated *Fomes annosus* to be the pathogene and the cord-like rhizomorph which is generally found between the bark and the wood, to belong to it, *Armillaria mellea* playing the rôle of a saprophyte. Six years ago when the work on this problem was begun, it was found that the kail having replaced the spruce in the infected areas had contracted the disease from the spruce. Wherever deodar was planted to replace the spruce in these areas it also suffered the same fate. Inoculation experiments were conducted with cultures of *Fomes annosus* and *Armillaria mellea* on the three different types of conifers concerned, and both the fungi were found to be pathogenes. The young plants of *Pinus excelsa* and *Cedrus deodara* in the plantations on the terraces are killed by *Fomes annosus* and the mature trees of *Picea morinda* by *Armillaria mellea*. *Fomes annosus* is not usually supposed to be capable of infecting healthy roots. It is often stated to enter roots injured by other causes, generally through root wounds. The history of the plantations shows that these terraces where now the pines and the deodars grow, were previously fields of potatoes and other agricultural crops or cut over indigenous forest lands. The soil of the agricultural or the old forest land was, therefore, highly acid. During the management of the earlier stages of the plantations, from the time of the transplanting of the seedlings up to their growth to the pole stage, the ground was covered with a thick growth of weeds which come up annually in spring and die down in autumn, adding to the thickness of the humus already present, and increasing the acidity of the soil. This factor coupled with others such as deficient drainage of the sub-soil, the terraces in most cases dipping towards the hillside, leads to an accumulation of water and consequent asphyxiation of many of the deeper roots of the trees. The absence of sunlight in the crowded plantations also acts both directly and indirectly in exposing the young conifers to the infection of *Fomes annosus.* In a young plantation, the symptoms of die-back are apparent at this stage, and before the plants pass on to the pole stage, the infection of *Fomes annosus* becomes widespread.

The fungus probably spreads by mycelium growing through the ground and by spores washed down through the soil or carried on the fur of burrowing rodents. The writer has not come across any type of organized rhizomorph with *Fomes annosus* but there are light brown mycelial strands which are of a temporary nature, appearing during the rains and disappearing after the autumn. The cord-like rhizomorph as noted by Hole (14), belongs to *Armillaria mellea.* The fructifications are produced at the base of the trunks at ground level, but they do not usually occur till the decay is far advanced. The most interesting outcome of this investigation was the discovery of a saprophytic form of *Fomes annosus* which exists side by side with the parasitic form. *Fomes annosus* has since been reported to have killed young deodars and pines from various other coniferous forests of the Himalayas, from Upper and Lower Bashahr, Simla Hills, Kulu and Kashmir.

Armillaria mellea is typically a root-rot organism and is capable of invading healthy roots. It causes a soft, white, stringy rot with conspicuous black zone lines. The pathogenecity of this fungus on *Pinus excelsa* and *Cedrus deodara* has been proved by inoculation experiments, while on the girdled spruce (*Picea morinda*) and fir (*Abies pindrow*) the fungus behaves as a sap-rot and the shiny horse-hair rhizomorph is found between the decomposed bark and the sapwood.

Trametes pini was held responsible for the brown heart-rot of conifers, specially of *Pinus excelsa*, and this was worked out in detail by Hole (15). Observations were also made in Somban block, Kulu, that *Trametes pini* is in addition a wound parasite on deodar. Reports of extensive damage to kail, deodar and chilgoza pine (*Pinus gerardiana* Wall.) by this fungus have been received from Upper Bashahr and Kashmir. The rot also passes on to sleepers during conversion as initial pocket rot, which in the sleepers or other timber used for construction is likely to extend under favourable conditions, and if suitable steps are not taken to treat the timber in order to check the rot, the decay will be hastened and the results will be disastrous. The rot has been found to pass on to green timber by contact. The conditions under which the infection of fungus spreads to the timber after exploitation, require a thorough investigation. The problem is interrelated with timber pathology and timber physics, including seasoning and wood preservation.

The infection of *Trametes pini* in India was a subject of speculation. In course of our work with the coniferous diseases the brown-heart-rot was reproduced by direct inoculation of pure culture of *Trametes pini* through old branch wounds on *Pinus excelsa* and *Cedrus deodara.*

III. Under canker and die-back there are some interesting problems of local importance. The pathology and physiology of canker, that is, the formation of canker and the factors predisposing the trees to infection, form interesting side line to canker problems. So far as the observations go the canker-forming organisms of the Indian forest trees mostly belong to the *Ascomycetes* (*Pezizales* and *Hypocreales*) and contain pathogenic and wound parasite types. Frost and fire are the common causes in producing such wounds, but abnormal drought has also been found to produce lesions by desiccation in the young stems of some of the hardwood spp. through which the canker organisms gain entry. Insect punctures in green shoots also can be similarly responsible for such infection.

We have two new species of *Ascomycetes* one of which a *Nectria* causes die-back of a more or less widespread nature. The victims include a large number of avenue trees of diverse spp. such as the *Casuarinas*, *Cassias*, *Cupressus*, introduced *Erythrinas*, *Eucalyptus*, and so forth. The second species, a *Dasyscypha* the perfect form of which was noticed for the first time two years ago has practically killed a whole avenue of exotic *Acacia* at New Forest.

The *Valsaceae* are often noted doing sporadic damage to some of our garden plants such as the *Gardenias* and *Magnolias*, but one of them has been found to cause an extensive and serious twig-blight and die-back of a whole plantation of *Gmelina arboria*, the gumbhar trees.

A canker disease of considerable importance appeared in a plantation of rosewood, *Dalbergia latifolia*, after two successive years of heavy frost, and a large number of trees was affected. The fungus responsible was found to be an unrecorded species of *Valsaceae* and the channels of entry were frost cankers on the stem. A canker disease of *Pterocarpus marsupium* apparently caused by another *Ascomycetes*, has practically wiped out a small plantation of about 300 vigorous trees in Dehra, *Polyporus gilvus* as already mentioned, being a secondary organism.

IV. A healthy, clean, and well-maintained nursery forms the foundation of a healthy forest raised by plantation. The nursery is of very great importance when a forest has to be restocked by culture and plantation, and therefore the study of nursery diseases is required.

High temperature during the driest period of the year which bakes the surface soil and injures the roots, and high humidity following it during the rains are the two main factors leading to the incidence of damping off in the forest nurseries in the plains, where the cultural operations of most of our hardwood spp. are carried out. Further, along with the high temperature and the atmospheric humidity the influx of soil moisture during the onset of monsoon rains, a large per cent of acid is washed down which increases the concentration of salts in the topmost layer of the soil. This has an inimical action on the rootlets during the pre and post emergence of the pathogenes. In the coniferous nurseries also, the same factors, that is, high temperature in summer and soil moisture in the monsoon before the emergence of the pathogenes, are the factors predisposing them to infection, although the maximum temperature is not as high as that of the plains.

The incidence of damping off is also correlated with the hydrogen-ion concentration of the nursery soil. The *ph* value of the soil fluctuates, the range of variation being 6·5 to 4·5 from the driest to the wettest period, i.e. from April to the end of August, and during the latter part of monsoon, i.e. in September, the acidity increases to 4 or even 3·8. The maximum per cent of wilting is marked at this time. The above data is taken on the basis of a hundred weekly tests, from 24 untreated beds of soil in the nursery of the Forest Research Institute, Dehra Dun. After September, the acidity decreases steadily, and the hydrogen-ion concentration of the soilal most reaches normal, i.e. 6·0 to 6·3 during the month of November when practically no wilting is noticed.

Fungal pathogenes affecting the nursery stock and causing damping off and wilt belong to various species of *Fusarium*, *Rhizoctonia*, *Corticium*, *Pythium*, etc., while in a few cases the disease is due to *Botrytis*. The pathogenic forms are isolated from time to time, along with other soil organisms. Experiments are conducted on various types of soil culture, in open beds, with soil, sand, farmyard manure, and basic-slag mixture, and the pathogenes are introduced in the beds, mixed with the non-pathogenic organisms, and the percentage of damping off and wilt is recorded for each type of soil mixture. While sterilized soil culture is not of much importance in the forest nurseries, experiments are also conducted in pot and pan cultures in sterile condition, and sometimes fungicidal treatment of soil is resorted to, to work out methods of control when other methods fail to be effective.

The investigation on seed-borne parasites is undertaken to certify seeds for export. So far about 80 species of such fungi in various spore-forms have been recorded on about 20 common species exported, shisham alone carrying 11 species of parasites, teak 7 and chir 6. The fungus pests so far identified are mostly *Deuteromycetes*, and show 20% of *Fusarium*, 5% of *Rhizoctonia*, 3% of smut-spores, 2% of *Botrytis* and 2% of *Pythium*. Out of the 80 it was possible to identify only 28. The available information on the subject is so meagre that it is difficult to make any progress in the obscure region, and unless some workers specialize in the study of the tropical seed-borne parasites, the subject will always remain obscure.

The introduction of root-and-shoot cutting (trunchon) method of propagation of forest trees has given us an opportunity to investigate into the mode of introduction of root-and-collar fungi in our hardwood deciduous forests in the process of regeneration. Specimens examined from time to time covered a wide selection of trees, e.g. the teak of Burma, Madras, and Bengal, the shisham of U.P. and the Panjab, the babul of C.P., etc. *Schyzophyllum commune*, *Fomes annosus*, *Polyporus gilvus* and *Fomes badius* are the fungi generally found to be the causes of the rots.

Most of our forest diseases including heart-rots are indigenous and have existed in this country as far back as history can trace them. Such diseases seldom become epidemic, the organisms causing them being more or less in a biological balance with their hosts. When this balance is disturbed by unusual weather conditions or other factors, an indigenous disease temporarily becomes epidemic; when the disturbance ends, the disease resumes its former status effecting cumulative damage through slow and constant action. But parasites coming into a new region often find some species particularly susceptible to their attack, because of the lack of any established balance between the parasite and the host, and thus an epidemic breaks out.

Having so far discussed the tree diseases with which we have come in contact and the theories of predisposing factors which bring about the infection under natural conditions in the forests, we now pass on to the possibilities of control measures.

There are apparently various methods of controlling plant diseases as given in different text books but the question is whether it is possible to bring them into actual practice particularly in a country where the variations of climatic conditions are extreme at different times of the year, and where we are hampered by the disadvantage of inadequate resources and a lack of public education in this direction.

Leaving aside such remedial measures which cannot be applied in large proportions to our diseased forest trees, let us see if a scheme for controlling the diseases can be evolved in cooperation with other sister sciences with which mycology and plant pathology are very much interrelated. Reference may be made to plant breeding and soil sciences including soil chemistry, soil physics and soil microbiology, the development of which is comparatively recent.

It has been mentioned before that most of the root diseases of the forest trees are due (to the changes of the mineral constituents ? and) to the fluctuation in the hydrogen-ion concentration of the soil. For instance, we can mention the shishàm wilt disease which is very difficult to deal with from the point of view of control and in which the pathogene or the causal organism (*Fusarium sp.*) is always present in the soil where shisham flourishes as well as where it dies. There is an equilibrium between the organism and the normal function of the roots which is disturbed by the hydrogen-ion concentration under certain conditions and it is this disturbance which may be regarded primarily responsible for creating conditions for infection. The infection of deodar by *Fomes annosus* in the hills where the soil is definitely acid owing to the presence of humus, as previously stated, is an instance which may be cited in this connection. The same applies to nursery diseases such as damping off and wilts, etc. The cooperation between mycology and soil sciences is therefore necessary to work out the control.

The selection and breeding of resistant varieties of forest trees in place of the susceptible ones may be helpful in eradicating some of the diseases, considering the results achieved by the agricultural department in introducing such resistant varieties. There appear to be similar possibilities with regard to forest trees and it is hoped that a beginning in this direction would be made in the near future by plant breeders. The establishment of immune varieties of forest trees by selection has been adopted by the present forest management in America though not on a large scale.

A biological control measure more or less on the same lines as adopted against insect pests deserves consideration. There are instances where fungi ordinarily saprophytic may become antagonistic in their reaction to or parasitic on other fungi which are harmful to higher plants (26). Advantage of this phenomenon may be taken to control some of our root diseases in collaboration with soil microbiology as it is an interrelated problem. Attempts may be made to develop this line of investigation which may lead to satisfactory results. But it has to be admitted that it requires an intensive study of the soil organisms and a complete knowledge of the life history of the parasites.

The eradication of tree diseases as well as the exercise of prophylactic methods at present depends a great deal on the management of the forests. Control of some of the parasitic diseases can be effected by means of forest sanitation and stand improvement. Forest sanitation besides other factors involves the removal of trees which are infested with cankers and fruiting bodies of various fungi and also of those which from any other reason are sources of infection to the crop trees. This not only reduces sources of infection but gives young trees an opportunity to occupy more space and develop satisfactorily. Moreover, trees chosen in stand improvement operations to be left as crop trees should be free from any taint which will deteriorate their quality. The health of the individual is as important as the health of the species inasmuch as the former depends on the latter.

V. It is only during recent years that timber pathology has gained prominence along with wood-preservation and the toxicity tests of various preservatives. It has been realized that for the safe utilization of timber, the wood must be treated with poisons or chemicals so as to enable it to stand against premature decay and decomposition by fungal and bacterial rots.

The choice of the fungi for testing the toxicity is based on their relative economic importance, and the vigour of growth and amount of decay is measured by loss of weight. The list includes such fungi as *Polystictus hirsutus*, *Polystictus versicolor*, *Polystictus sangunias*, *Trametes lactineas*, *Polyporus shorea*, *Trametes pini*, *Fomes annosus*, etc., but other isolations from wood decayed in storage and construction work have supplemented the fungi regularly used. Some dry rot organisms, isolated several years ago from treated wood, are specially valuable in the assay of organic preservatives, though unfortunately, they have not been identified as yet.

We had an opportunity of examining for dry rots all types of timber used for various construction purposes, e.g. Sitka spruce used for aeroplane propellers, Canadian elm and Burma teak for hulls of sea-going vessels, various coniferous woods which constitute the wooden structure of everyday transport, teak used for the construction of theatre galleries, sal and chir which make garage pit-covers, and sal poles used for carrying transmission cables, etc. It may be seen that the above list covers both hardwood and coniferous species, homegrown as well as exported.

The behaviour of some of these wood-rotting organisms is peculiar and rather specific with regard to the types of preservatives used. Some offer resistance to organic preservatives while others exhibit sensitiveness to metallic salts. This idiosyncracy of fungi to different kinds of poisons and their reaction to various salts is a matter of common observation to timber pathologists who are engaged in the investigation of wood preservatives. But it is for the chemists to explain what changes take place in the wood when it is treated with such chemicals. Is it the change in the chemical composition of the wood alone or also in the hydrogen-ion concentration of the wood that are jointly responsible for the attraction and detraction of different fungal organisms to the same chemicals when used on identical wood?

The characters of the rots of different organisms also differ greatly. On the same wood some organisms produce a marked surface erosion while others induce pocket or spongy rots. The subject requires further study and observation. It will be seen that while primarily intended for appraisal of preservatives the method also lends itself to studies of rot resistance of various woods.

The test blocks of wood used for experiment are selected from uniform sap and heart wood of sal (coarse grained), and shisham (fine grained) for hard-wood spp. and chir (*Pinus longifolia*), and deodar for coniferous spp.

The problem of testing toxicity gradients of wood preservatives which appears to be a simple one presents, however, difficulties inducing errors or drawbacks. I shall briefly sketch some of these.

We all know that fungus activities in wood or artificial media start and continue as long as the moisture conditions are suitable. There are, in this respect, maximum, optimum, and minimum conditions. The experiments are generally started with a known percentage of moisture in the wood-cells of these blocks, and it is required that the moisture should periodically be determined as the fungus activities continue. The blocks cannot be removed from the culture flasks to determine the moisture condition because of the possible risk of exposing them to contamination. This presents a difficulty which yet remains to be overcome.

The work becomes more complicated when wood blocks are treated with toxic substances. To start with, the blocks have to be treated with very weak solution, the fungus has to be taken through grades of poison, as it were, and the proper toxic dose has to be worked out. A difficulty arises because of the phenomenon of absorption and the tendency of the toxic substances to leach out. We know that all cell walls do not absorb the toxic substances to the same degree or intensity, or retain them to the same extent, and that some of the substances escape into the culture media, and the wood block is then invaded. In order to be accurate, the assaying of the leaching out of the chemicals has to be done side by side with the assaying of the chemicals absorbed. The assaying of the leached out chemicals becomes still more difficult, if the treated test pieces have to be weathered naturally or artificially, before inoculation.

Another complication arises in the grading of the action of these organisms as active, moderate, or weak wood-rotting agents. This can be done by an examination of the microscopic character of the rotted wood, and the determination of the strength and the structure of the wood tested after periodic decay, along with, of course, the determination of simple loss by weight. But this also being an empirical method, accuracy cannot be expected.

There are simple wood staining organisms such as *Ceratostomella pini* which also may cause an appreciable loss of weight, without causing any weakening whatsoever of the wood, as the fungus lives on the stored up material of the cells. There are others, such as the *Graphium* type which punctures the wood without appreciably weakening it, and there are the very active rotting agencies such as the *Polyporaceæ*; the *Schizophyllaceæ*, the *Irpex*, and a number of other organisms causing dry rots. But this is an entirely arbitrary grading, and experiment is required at every step to standardize it scientifically.

VI. So far I have been relating the harm done by the fungal organisms to the forest trees. I would also like to point out some advantages that the forests derive from the existence of fungi.

Those acquainted with forests have seen how dead trees and fallen branches get covered with garlands of fungus sporophores and how in the course of time they are reduced to pulpy masses which mix with the soil. Fungi serve a very useful purpose in the economy of nature, as they convert with the help of bacterial organisms all useless organic substances into more or less inorganic ones, always renovating and enriching the resources of nature for the life and growth of new things. The importance of fungi can scarcely be said to be exaggerated when we consider their function in this light.

Some fungi act as symbiotic organisms and provide nutrition for the trees on which they grow. But the mode of life and behaviour of the same organism under different circumstances or of closely related species under the same conditions appear surprisingly different. The same fungus may behave as a violent parasite in one case, in another it may be a saprophyte, or even a symbiotic organism. We cannot morphologically distinguish between these three forms of the same fungus, and so specific names cannot be given. They may be described as physiologic forms of the same species.

For example, we have seen that *Armillaria mellea* is a primary parasite on conifers, and another *Armillaria* sp. is a pure saprophyte, while a closely related species, *Armillaria fuscipes* produces mycorrhizal mantles on the roots of the low altitude oak, *Quercus incana*. *Fomes annosus* also behaves as a primary parasite on spruce, kail, and deodar, while *Fomes annosus* (var. *indicus* Wkf. ?) is a saprophyte which grows on decomposed logs or felled trees. *Cantherallus flabilifera* is a mycorrhizal form, and the hyphal strands forming fungus mantles have been traced to the roots of *Abies pindrow*. *Irpex* sp. which grows on the stumps and fallen logs of spruce, deodar and kail, as weak parasite, produces dry rot on all the conifers on the hills. *Corticium* sp. which is usually a saprophyte on decomposed stumps of khursoo oak (*Q. semicarpifolia*), behaves like a wound parasite on the same host, when it enters through fire scars. *Polystictus versicolor* which is a saprophyte and purely a wood-decaying organism, acts like a parasite under favourable conditions. *Schizophyllum* sp. which is normally a saprophyte in nature, may also be a very active parasite, producing canker on various conifers; so also its cousin *Schizophyllum commune*, which is primarily a wood-decomposing organism, assumes a parasite habit. Out of ten railway sleepers examined for rot, six showed *Schizophyllum commune* as the causative agent. In Dehra this fungus is a cause of die-back of various fruit trees.

The habits of some other fungi may give us an insight into the character of soil suitable for certain timber trees, for example some form of soft toadstool fungus, the *Agarics*. *Marasmius urens* is typical of good oak forest land; *Psalliota* sp. with mauve and olive forms is always an indication of good khursoo oak forest, while those white in colour, can be taken to signify spruce and fir forests.

These observations on the forms and habits of *Agarics* are very cursory, and at this stage, no definite conclusions can be drawn, but studies have their possibilities, and their proper application to our forest science may bring fruitful results. An oak tree bedecked with a number of fungal fruit-bodies, for instance, two spp. of *Corticiums*, two of *Polyporaceæ*, one of *Hydnaceae*, two types of *Agarics*, and one of slime mould, each trying to get the uppermost, or a sal tree sheltering three species of *Fomes*, one of *Schizophyllum*, and one of *Polystictus*, are to a mycologist instances of great interest and significance. It is interesting to investigate which of these are trying to save and which to kill the victim or to get the most out of it.

I would like to conclude this address with an anecdote in connection with this work. A renowned Continental Botanist once visited our laboratory when we were busy with cultures and rots. He spent an hour with us, discussing the problems of Indian tree diseases which we all know to be of immense variety because of the inumerable species of trees and vast differences in climatic conditions. Then he said in broken English, but with dramatic assurance, 'Your country abounds in fungus. Every tree has its disease, every timber its rots, every leaf its rusts and spots. And it seems you are happy with it all'. Gentlemen, I must confess that he was right. I certainly feel very happy at the extent of work before the mycologists in India, of whom it is my proud privilege to be one.

APPENDIX A.

	RUST	HOST
I.	*Peridermium himalayense* Bagchee *Cronartium himalayense* Bagchee	*Pinus longifolia* Roxb.
II.	*Peridermium orientale* Cooke *Coleosporium campanulæ* (Pers.) Lev.	*Pinus longifolia* Roxb.
III.	*Peridermium indicum* Colley and Taylor. *Cronartium ribicola* Fischr.	*Pinus excelsa* Wall.
IV.	*Peridermium brevius* (Barclay) Sacc. *Coleosporium barclayense* n.sp.	*Pinus excelsa* Wall.
V.	*Peridermium picea* (Barcl.) Sacc. *Chrysomyxa himalensis* Barcl.	*Picea morinda* Link.
VI.	*Peridermium thomsoni* Berk. and Cke.	*Picea morinda* Link.
VII.	*Peridermium cedri* (Barcl.) Sacc. ..	*Cedrus deodara* Loud.
VIII.	*Peridermium* sp. near *cerebrum* ..	*Pinus khasya* Royle.
IX.	*Peridermium* sp.	*Pinus khasya* Royle.
X.	*Peridermium abies-pindrowensis* n.sp. *Uredinopsis* sp.	*Abies pindrow* Spach.
XI.	*Chrysomyxa deformans* (Diet) Jaczew.	*Picea morinda* Link.
XII.	*Chrysomyxa picea* Barcl. ..	*Picea morinda* Link.
XIII.	*Chrysomyxa* sp.	*Pinus excelsa* Wall.
XIV.	*Chrysomyxa dietellii* Syd. ..	*Rhododendron arboreum* Sm.
XV.	*Gymnosporangium cunninghamianum* Barclay.	*Cupressus torulosa* Don.
XVI.	*Gymnosporangium distortum* Arthur and Cummins.	*Cupressus torulosa* Don.
XVII.	*Peridermium ephedra* Cke. *Hyalopsora* sp.	*Ephedra vulgaris* Rich.

APPENDIX B.

	RUST	HOST
1.	*Coleosporium inula* (Kunze) Rabenh.	*Inula cappa* DC.
2.	*Coleosporium oldenlandia* (Massee) Butler.	*Oldenlandia aspera* DC.
3.	*Coleosporium campanula* (Pers.) Lev.	*Campanula colorata* Wall. „ *canescens* Wall.
4.	*Coleosporium plectranthi* Barclay	*Plectranthus gerardianus* Benth and other spp.
5.	*Coleosporium clematidis* Barclay	*Clematis montana* Ham. and other spp.
6.	*Coleosporium leptodermidis* (Barclay) Syd.	*Leptodermis lanceolata* Wall.
7.	*Coleosporium myriactidis* Syd.	*Myriactis wallichii* Less.
8.	*Coleosporium* sp.	*Senecio rufinervis* DC. „ *alata*, Willd.
9.	*Coleosporium* sp.	*Senecio graciliflorus* DC. „ *chrysanthemoides* DC.
10.	*Coleosporium* sp.	*Pedicularis gracilis* Wall.
11.	*Coleosporium* sp.	*Pieris ovalifolia* D.Don.
12.	*Pucciniastrum coryli* Kom.	*Corylus colurna* Linn.
13.	*Pucciniastrum aceris* Syd.	*Acer cæsium* Wall.
14.	*Pucciniastrum agrimonia* (Schw.) Tranzsch.	*Agrimonia eupatorium* Thw.
15.	*Pucciniastrum coriariæ* Diet.	*Coriaria nepalensis* Wall.
16.	*Phakopsora cronartiiformis* (Barclay) Diet.	*Vitis himalayana* Brandis.
17.	*Chnoopsora sancti-johannis* (Barclay) Diet.	*Hypericum cernuum* Roxb.
18.	*Uredinopsis* sp.	*Lastrea filix-mas* Linn.
19.	*Hyalopsora* sp.	*Athyrium acrostichoides* Diels.
20.	*Hyalopsora* sp.	*Adiantum venustum* Don.
21.	*Hyalopsora* sp.	*Cheilanthus dalhousiæ* Hook.
22.	*Milesis* sp.	*Dryopteris odontoloma* (Moore) C. Chr. „ *marginata* (Wall) Christ.
23.	*Milesia* sp.	*Pteris cretica* L.
24.	*Milesia* sp.	*Coniogramme fraxinea* (Don.) Diels.
25.	*Chrysomyxa himalensis* Barclay	*Rhododendron arboreum* Sm.
*26.	*Chrysomyxa deformans* (Diet) Jaczew.	*Picea morinda* Link.
*27.	*Chrysomyxa picea* Barclay	*Picea morinda* Link.

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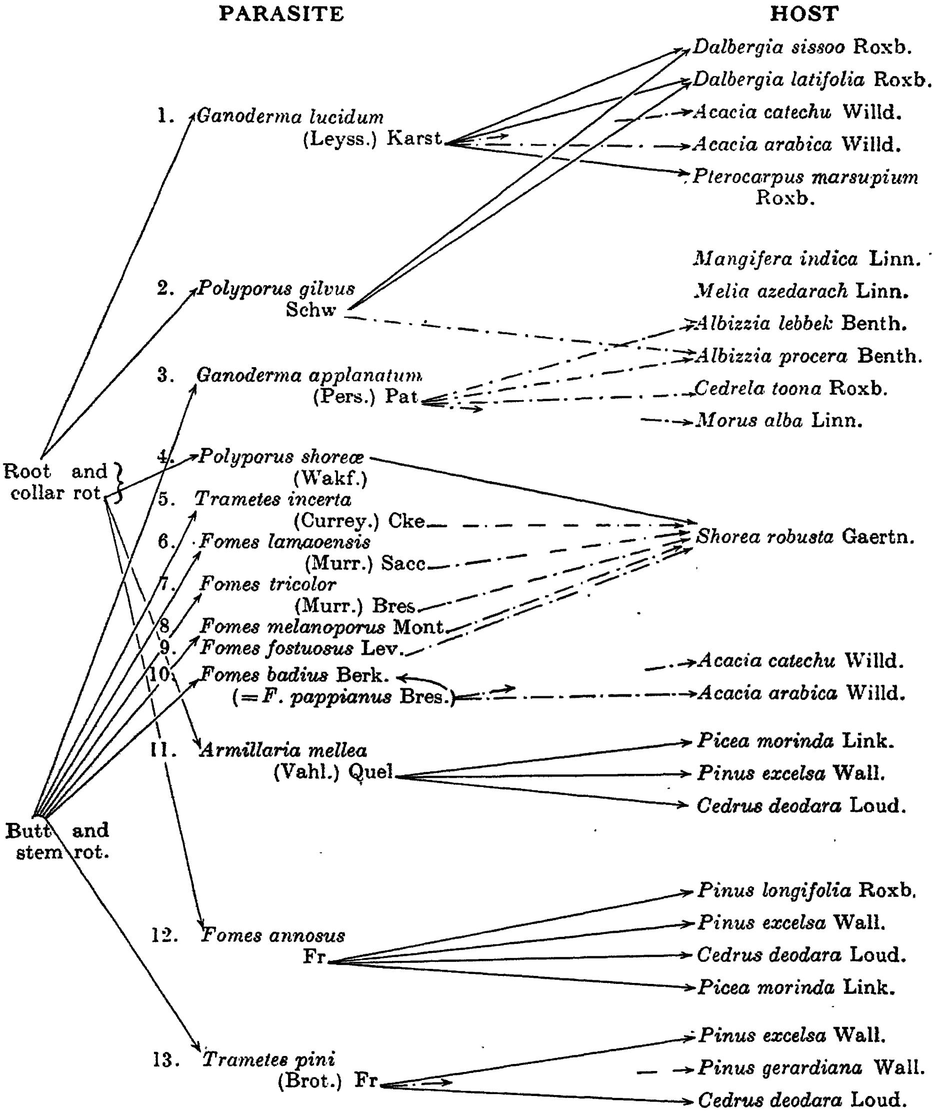
* On coniferous host.

APPENDIX C.

1.	*Peridermium himalayense* Bagchee (*Pinus longifolia* Roxb.)	*Cronartium himalayensis*-Bagchee. (*Swertia augustifolia* (Buch.) Ham. *S. alata* Roxb. and *S. cordata* Wall.)
2.	*Peridermium indicum* Colley and Taylor. (*Pinus excelsa* Wall.)	*Cronartium ribicola* Fischer. (*Ribes rubrum* Linn. *R. orientale* West.)
3.	*Peridermium* Sp. (near cerebrum) (*Pinus khasya* Royle.)	Unmatched.
4.	*Peridermium cedri* (Barclay) Sacc. (*Cedrus deodara* Loud.)	Unmatched.
5.	*Peridermium orientale* Cke. (*Pinus longifolia* Roxb.)	*Coleosporium campanula* (Pers.) Lev. (*Campanula colorata* Wall.)
6.	*Peridermium brevius* (Barclay) Sacc. (*Pinus excelsa* Wall.)	*Coleosporium barclayense* nov. sp. (*Senecio rufinervis* DC.)
7.	*Peridermium picea* (Barclay) Sacc. (*Picea morinda* Link.)	*Chrysomyxa himalensis* Barclay. (*Rhododendron arboreum* Sm.)
8.	*Peridermium thomsoni* (Berk) Cke. (*Picea morinda* Link.)	Unmatched.
9.	*Peridermium abies-pindrowina* nov. sp. (*Abies pindrow* Brandis.)	*Uredinopsis* sp. (*Lastrea Filix-mas* Linn.)
10.	*Peridermium ephedra* Cke. (*Ephedra vulgaris* Rich.)	*Hyalopsora* sp. (*Athyrium acrostichoides* (Sw.) Diets.
11.	*Peridermium* sp. (Needles of *P. khasya* Roxb.)	Unmatched.
12.	*Chrysomyxa deformans* (Diet.) Jaczew. (*Picea morinda* Link.)	"
13.	*Chrysomyxa piceæ* Barclay (*Picea morinda* Link.)	
14.	*Chrysomyxa dietellii* Syd. (*Rhododendron lepidotum* Wall.)	"
15.	*Chrysomyxa* sp. (*Pinus excelsa* Wall.)	"
16.	*Gymnosporangium cunninghamianum* Barclay. (*Cupressus torrulosa* D. Don.)	*Pyrus pashia* Ham.
17.	*Gymnosporangium distortum* Arth. and Cummins. (*Cupressus torrulosa* D.Don.)	*Cotoneaster bacillaris* Wall.

APPENDIX D.



(1) The complete lines of the arrows connecting the parasites and the host refer to experiments completed;
(2) The dotted lines refer to experiments in progress;
(3) The incompletely lined ones are under consideration.

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SECTION OF ZOOLOGY

President :—C. R. NARAYAN RAO, M.A.

Presidential Address

BATRACHIANS AND THEIR ENVIRONMENT

My study of batrachians is limited to South India, where we get a sufficiently diversified range of environmental factors to provide a mass of evidence of exceedingly interesting problems in biology. The environmental relations of animals when sympathetically approached will reveal topics in whose elucidation, we may have to traverse beyond the descriptive level of science. All the critical phenomena, with which we are confronted in ecological studies, are capable of being assembled under theoretical systems, which form the subject-matter of analytical biology. We know that theory and experiment are complemental and together constitute the basis of science. Even in biology there is room for theoretical concepts, which are not to be confused with superfluous speculations. Now it is this aspect of biology which, combining both theoretical and experimental modes of approach to the problems of living organisms, needs emphasis and wider appreciation in the universities.

It is true that the boundaries which limit the extent and scope of ecological studies are still ill-defined, but this indefiniteness need not hamper the recognition of the fact that all the reactions of organisms to the environment are deducible to simple physiological processes. We know that ecology deals directly with the environment itself, and its study will naturally include the physiological (and I do not use the word physical) properties which have importance in a natural environment and the relations of organisms to environment determining their morphological variations, bionomics and distribution. You know that the relations of animals to environment may be studied from the standpoint of the individual species or from the standpoint of communal associations. I shall present the results of my observations on the batrachian life from these two points of view.

One of the first lessons taught in biology is that the capacity of an animal to maintain itself is pitted against those factors which make up its environment, and that these factors include sudden changes of temperature, periodical occurrence of drought and floods, presence or absence of food, shelter and protection, the rate of reproduction and mortality and finally the power of resisting or escaping from natural enemies. We know that the amphibians are susceptible almost to every one of these factors, and the adaptive modifications which have resulted in their survival form one of the most fascinating studies in biology. Amphibians have become adapted to the conditions of their existence both by somatic and genetic processes.

The physiographical features of South India present a wide range of differences in respect of altitudes, distribution of grassy plains and forests, cultivated fields and waste lands, perennial sources of water supply and arid tracts, together with the physical differences in the atmosphere expressed in the climate, *viz.*, humidity, temperature, pressure and movement of air according to their periodic and non-periodic fluctuations during the course of the year. The environmental complex, therefore, under which the batrachians live is decidedly more varied than fell to the lot of their aquatic ancestors. The humidity of any place, it is well known, depends upon the evaporating power of the air, and its amount is determined by the area of exposed water surfaces, by the proximity to higher altitudes covered by the density of vegetation and the direction of the sea breezes. Other conditions being equal, a higher content of moisture favours the presence and abundance of batrachian fauna, but requires fewer adaptive modifications on the part of these primitive air-breathing vertebrates. However, it is interesting to note that batrachian life is not bound by unalterable values of the conditioning factors, and its ecological valence in respect of humidity extends over a fairly wide range of physical conditions, but not, as a rule, in the case of all species. It would be appropriate to describe the amphibians as stenohygric, though there are a few exceptions. It is not common to find among them examples which can hardly subsist out of water, and others capable of living continuously under conditions of extreme dryness. Protection against desiccation is never developed uniformly in the various families of batrachians met with in South India, and the capacity to withstand dry conditions occurs in different degrees of gradation. I shall give a few examples affecting dry situations in which the structural modifications for the preservation of moisture have been produced along different interesting lines. The members of the group Microhylidæ and Bufonidæ and some genera in the Ranid family live habitually either in deep burrows or in dry regions, except for a short humid period. In the genus *Uperodon*, the horny investment of the skin is not thin as in the case of purely aquatic species of *Rana* (*R. hexadactyla*) and the histological details of the skin present a variety of large spaces between the glandular and other cellular elements, in such a conspicuous profusion that there can be little doubt that these spaces are intended to absorb and retain water during the wet weather, to be used in seasons of extreme drought for protection against being dried out. These special cutaneous adjustments have enabled the members of this genus and other genera, such as, *Microhyla* and *Ramanella* to extend into warmer regions of the Malnad belt, and into dry areas with occasional rains. This device for the saving up of water insures the possessor against injury due to lack of moisture, and it is correlated with two other pronounced internal structural modifications in *Uperodon* and *Ramanella* and less so in *Microhyla*. The aquatic batrachians have comparatively large kidneys as are to be found in *Rana hexadactyla*, and these provide for the increased necessity of renal excretion, so essential in the case of animals dwelling in fresh waters. In consequence of the environmental stimuli of a different order, the structural changes in the Microhylid group have assumed the form of a proportional diminution in the size of the kidneys and a corresponding increased volume of the bladder. I have examined these batrachians obtained in every season over long periods of time, and the marked differences in the size of the excretory organs form a definite feature of this group, and are expressive of the adaptive somatic reactions to the conditions of the environment. The water absorbed by the skin is excreted by the renal organs and is collected in their enlarged bladder, where it remains with very little and infrequent evacuations. Further, it may be pointed out that the amount of excretory products in the urine of these animals is surprisingly small as compared with the contents of the bladder of the aquatic examples. Thus in *Uperodon* and *Ramanella* we encounter these extreme modifications, and in the other members of the Microhylid group they are less pronounced, for they are cryptic forms and have access to water in the gardens and wet situations which they generally frequent. Here is an instance of a single family in which the closely allied animals have differentiated into xeric and hygric groups with conspicuous somatic changes. Apart from these structural modifications, I have grave doubts whether the family Microhylidæ (corresponding to Engystomatidæ) may be treated as a natural group. In respect of cranial arrangement of bones, the different structural relations of the brain and their proportion and development, and the disposition of valves in the Conus and the mode of origin of arches, and finally the interrelation of the different elements composing the larynx, we find such general and widespread deviations that the genetic homogeneity of the groups may be seriously questioned. It appears to me that the structure of the pectoral girdle used mainly for the establishment of taxonomic relationship cannot be accepted as a safe and satisfactory guide for seeking genetic relationship. The absence of an omosternum is not peculiar to the family Microhylidæ, and this character is noticeable also in the members of the Ranid group in various stages of imperfection. We know that the structural alterations of the girdles in general and those of the diapophyses of the last vertebra in particular, are the direct result of the mechanical stress and strain exerted upon them by the animals, either burrowing, hopping, climbing or crawling. The girdles of amphibia anura are in several examples only cases of convergence. Coming back to the stenohygric forms, we find that among the Bufonidæ and Ranidæ, there is an amplitude of variation as wide as in the Microhylid group, with corresponding regulative adaptations, designed to establish water economy, the principal factors involved being controlled evaporation from the skin and lungs, the increased concentration of the urine in the bladder, and its purity secured by the diminished rate of the excretion of nitrogenous waste. There is another interesting direction in which the physical differences in the character of the air and the water have produced peculiarities of habits affecting structural relations. I refer to batrachians, such as, *Rana hexadactyla, Uperodon systoma* and *Bufo fergusoni* on the one hand, *Rana tigrina pantherina, Microhyla ornata*, and *Bufo melanostictus* on the other, as examples of adaptive modifications in their general habits with reference to the condition of their skin. The first three members are compelled to rest the whole extent of their soft and slimy bodies on the earth, and when placed in the water they assume a perfectly horizontal position. But the second three examples sit with a forward slope on land and become perfectly vertical in water. Here we are dealing with a set of characters relating to the supporting structures of the body, produced entirely by the surrounding medium conditions of low and high densities.

Temperature is one of the important factors influencing the organization of the entire terrestrial fauna, and its exercise on the occurrence of batrachians in any area is usually more evident. In the hilly tracts and especially in the ghat section known as the Malnad, the amplitude of temperature variation ranges within wide limits, but the abundance of moisture and food is nature's compensation for the amphibians, and for that reason, these animals are stenothermal, limited to moderate and intermediate temperatures. Where, however, the heat during the summer touches 105°F. the batrachians æstivate till the return of rains and a fall in the temperature. Judging by the size of the several species and the members of the same species taken in different situations enjoying wide variations of temperature, I imagine that the Bergmann Principle is applicable even to poikelothermal animals, which must give off equal amounts of heat per unit of surface. It is, therefore, of great advantage for the maintenance of the metabolic activities for amphibians to have a reduced body surface. Temperature has a direct effect on the shape and size of the body, and in support of this view I might mention that the species of *Philautus* occurring in the colder altitudes, such as the Nilgiris have a greatly restricted and globular form. Similarly *Rana cyanophlyctis* and *Bufo melano-*

stictus, which occur in regions having the higher and lower temperatures, present a surprising difference in the size and shape of the adult members. Almost as a rule these forms, as well as other members conform to the theory of Bergmann in having the heat radiating surfaces reduced in cold climates, and in having the opposite effect produced by the higher temperatures. You are aware that the disappearance of the external tympanic disc in the Urodela is explained by the theory that their return to aquatic habits of life has led to its abolition. The extension of this theory to other groups such as Anura and Apoda is not tenable, for we find in *Rana hexadactyla*, *R .limnocharis* and *R. cyanophlyctis* and a few species of *Philautus* which are thoroughly aquatic, the tympanum is in a conspicuous state of development, while the whole family Microhylidæ which are distinctly terrestrial show an absence of this external membrane. *Bufo* is equally terrestrial and it is interesting to note that in the examples of this genus, the tympanic disc occurs in a marked form as in *B. melanostictus* and *B. parietalis*, greatly reduced as in *B. microtympanum* and *B. beddomii* or is wanting as in *B. fergusoni*. Even in the family Ranidæ there is a wide range of variation; for instance in *Nyctibatrachus* and *Nannobatrachus*, the members of which, especially those belonging to the former genus, are either aquatic or are terrestrial, the external tympanic disc is totally absent in some or fairly distinct in others. Similarly the whole group *Micrixalus* and some species of *Philautus* have a hidden tympanum. But on the other hand *Nannophrys* and *Rhacophorus* whose habits are terrestrial are, as may be expected, endowed with a well-developed tympanic membrane. It is doubtful whether the theory of the return to a purely aquatic mode of life invoked for explaining the disappearance of the tympanic membrane in the group Urodela will be applicable to Anura and Apoda, and if not, the arbitrary character of this membrane even among the species of the same genus will have to be accounted for by a different hypothesis. Before I proceed to offer an explanation, I must mention that the extremely interesting species *R. cyanophlyctis* offers a wide range of differentiation of the tympanic disc, and the relative size of development bears a close relation to the nature of the climatic conditions of the areas from which the specimens have been collected. But perhaps the arbitrariness in the members of the group *Philautus* is most bewildering. I have devoted a close and industrious attention to this problem, and have formed a tentative theory to account for the presence or absence of the external tympanic disc, and its validity should be, however, tested by further observation, and I must state at once that this hypothesis is based on a study of the South Indian batrachians with which I have had occasion to compare those obtained from Burma, Siam, Shan States and Ceylon. To my mind the most satisfactory explanation is to be found in the extension of the Bergmann

Principle. Higher temperature induces the manifestation of the tympanic membrane in all its conspicuousness, lower temperature is a factor which tends to its cryptic condition or to its absence as a defined structure. External tympanic disc has no value in amphibian taxonomy. Dealing with those members of the Ranid family having a well-defined tympanic disc, we notice that they are fairly large specimens, and occur in arid conditions or in the water exposed to temperatures ranging from 90°F. to 110°F., while a few others belonging to the same family with hidden tympanum are, as a rule, smaller in build and occur in colder situations, such as the hill tops and the interior of the evergreen forests, always in the close vicinity of water margins. Where, however, these temperate climatic conditions are not available, as for instance in the case of the members of Microhylidæ, we find that they escape the long periods of summer weather by æstivating, and you will have some conception of this mode of retreat for escaping the scorching heat of summer, when I mention that some specimens of *Uperodon systoma* have been exhumed from a depth of 5 to 6 feet underground; others like *Ramanella* hide themselves in the whorls of the cool long stalks of plantain leaves or tunnels of white ants, and *Microhyla ornata* and *Microhyla rubra* find a pleasant and agreeable habitat in the well-watered gardens, seeking shelter under flower pots. They therefore contrive to evade the rigours of heat in the places where their destiny is cast, and the different modes of life adopted by them, perhaps indicate that they belong to a stock which originally inhabited the colder latitudes. We have, however, no palæontological evidence in support of such an assumption. The contraction of the heat radiating surface of the body induced by low temperatures, also involves the tympanic membrane of the amphibians, leading to the disappearance of its external demarcation. Where such a necessity does not arise, due to the prevalence of higher temperatures, the early appearance of this structure in the ancestral forms of amphibia still persists without undergoing any variation. This generalization, based upon the examination of nearly the entire anuran fauna of South India and extended to a limited collection from closely related areas, is capable of being verified by its application to the continental forms.

Another aspect of the influence of temperature on amphibians is the effect it produces on their colouration, as may be gathered from the widespread occurrence of the seasonal dimorphism. This influence is almost uniform except perhaps in the case of these forms which dwell in places where the variation of temperature does not extend beyond narrow limits. Humidity and heat may be taken as the general factors favouring the deposit of cutaneous melanin, and while exposure to sunlight promotes the formation of uniform bright green and yellow, we have to seek among the cryptic forms for those extraordinary colour schemes which distinguish such examples as *Rana aurantiaca, R. malabarica, Uperodon systoma* and a few among the genera *Philautus* and *Micrixalus*. It is in the forest dwellers and in the great burrowers that we find a warm and rich colouration and distinctive and complicated patterns, and the conditions which promote the appearance of the different lipochrome constituents form a complex or intermixture of hereditary and environmental factors, but it must be observed that, while generally the influence of this complex is steady, its uniform effect on colour phenomena, is, however, interrupted by other external conditions. I shall mention some typical cases. The black or blue dots on the ventral surface from which *Rana cyanophlyctis* derives its specific name, and whose pigment belongs to the melanin group and therefore ought to be constant, almost completely disappear from both the sexes of animals taken in the hill tops (7,000–8,000 feet) and from the dark recesses of evergreen forests. Even the dark blotches on the back fade away from these specimens, leaving a uniform olive green on the dorsal and a dirty or chalky white on the ventral surface. Higher temperature ranging between 90° and 110°F. and a corresponding degree of humidity tend to produce the yellow (zooxanthins) and red (zooerythrins) lipochrome pigments, either individually or in combination as environmental factors. We know that apart from humidity and temperature, light as an environmental cause exercises a potent influence on the colouration of animals, but as an isolated factor its action is curiously restricted to the evoking of a single uniform colour whose tint depends largely upon the character of the environmental medium. For instance, I expect that examples of *Nyctibatrachus* should be clothed in vivid hues like *Bombinator* or *Dendrobates*, judging by the conditions under which they occur. The other favourable factors are in this instance sterilized by sunlight which all the examples of *Nyctibatrachus* and several forms of *Philautus*, notably, *Ph. variabilis, Ph. beddomii* and of *Micrixalus* such as *M. fuscus* and *M. saxicola* love, and are content to assume a simple, sober monochromatic garb, sacrificing the opportunities of wearing a multicoloured livery. Those members of the Microhylid family which escape from the barren effects of sunlight, more or less throughout the year, possess a rich combination of red, yellow, brown and blue in various tints woven into exquisite patterns, to which as well as to their possessors, sunlight is fatal. Apart from these colours most batrachians, chiefly the male members of the Bufonidæ acquire seasonal or nuptial colours and we know the significance of such colouration, which is not produced by environmental factors, but by the activity of hypophysis cerebri. The secretion of this gland also accounts for the development of horny brushes on the fingers and breasts of the male, manifestly to enable the males to acquire a firm grasp of the female during copulation. Generally docile and unoffending, the male toads become pugnacious and exhibit a firmer character for aggressiveness during the breeding season, owing to the functional importance of the thyroid and adrenal glands. In South India where we have a pronounced periodic cycle of seasons, ultimately the energy and activity of the frogs during the breeding season could be explained perhaps on the basis of the concepts of weather and climate which must incite the glands into functional activity.

The most fascinating section of the ecological study of amphibians is that which relates to their forest communal life. In the Malnad belt and in all ghats, the forests present a vertical series of strata available for animal occupancy and the amphibians inhabiting these regions are distinguished by certain well-defined morphological characters. The trees and shrubs which provide shelter may be classified under the following heads:—

1. Trees extending here and there up to 80 feet;
2. Lower tree tops from 40 to 50 feet;
3. Small trees ranging between 20 to 30 feet;
4. Higher shrubs about 10 feet, and
5. Forest floors and low shrubs.

This dense leafy canopy throws a heavy shade in the deeper parts of the rainy forests producing conditions unfavourable for the growth of grass, but the dead leaves which cover the floor preserve sufficient moisture and warmth offering protection to the amphibians. In the Malnad areas, the temperature in the deeper regions of the forests may range between 100° and 120°F. while in the more open parts and in the margins, the heat rarely exceeds 100°F. In these areas insect life abounds and naturally, favoured by humidity and tropical warmth, they become a perfect paradise for tailless amphibians. At first sight these forests with their luxuriance of vegetation may appear disappointing for the herpetologist, but that is because, most of the amphibians either burrow, or are perched on inaccessible rocks and tree trunks whose colour they resemble. I am not dealing here with those adaptive modifications such as the presence of adhesive discs, claw-like digits and webbed phalanges which are well-known to every student. I should like on the other hand to take two typical examples, *viz.*, *Bufo melanostictus* and *Rana cyanophlyctis* which dominate the plain country and which also extend into the forests and summits of hills, offering instances of the somatic and genetic modifications produced by the environmental complex. There is hardly any region in the forests where the common toad does not occur, and where there is a pool of water, no matter what the elevation may be, *R. cyanophlyctis* is sure to occur. In the impenetrable recesses of forests overgrown with matted scrubby jungle, the usual mode of progression of the amphibian becomes almost impossible, and they must naturally exchange hopping to creeping through such spaces as may occur in the impassable growth of vegetation. The effect is a general elongation of the body and in the case of the forest specimens of *R. cyanophlyctis* and *B. melanostictus*, the relative proportions of the limbs and the body are so markedly different from those found in the plain specimens, that a systematist might even treat the former as separate local varieties. In consequence of the absence of water on hilly slopes, *R. cyanophlyctis* contents itself with the soil moisture and what drips from the tree tops, and becomes habituated to a distinctly terrestrial existence as contrasted with the plain dwellers which are thoroughly aquatic. The effect produced by this change of habitat expresses itself in the reduction of the amount of webbing, which in the sylvan forms does not cover beyond three-fourths of the digits, and what is perhaps still more interesting is the partial and sometimes the total disappearance of that well-known habit of skipping over the surface of the water by a series of short leaps,—a habit for which this species and *Rana tigrina* (the bull-frog) and *R. limnocharis* (the paddy-field frog) are distinguished. The loss of this habit may not be due to the shrinkage of the web, but to the shortening of the hind limbs as compared with those which in the plains retain this peculiar character. The reduction in the length of the hind limbs overtakes the common toad also, which in the Malnad areas, can execute only short hops, and can crawl much in the fashion of another toad *Bufo fergusoni*. The size of the tympanum is another feature in which remarkable differences occur. It is distinctly marked in the frog *Rana cyanophlyctis* and the toad *Bufo melanostictus* obtained in the plains, but is comparatively greatly reduced in the hilly and forest members of the same species. As regards the shape of the body of these forms, there are two directions along which divergence has taken place. We find *Rana cyanophlyctis* and *Bufo melanostictus* with a marked tendency towards a more globular shape and also towards a more elongated shape. The latter feature they share with the species of *Philautus* and *Rhacophorus* which have to encounter and contend against sudden floods or take to creeping over slippery surfaces of rocks. In both *Rana cyanophlyctis* and *Bufo melanostictus*, this habit of crawling or climbing has affected the terminal phalangeal bones of the anterior digits which have accordingly acquired a claw-like shape. Specimens of these species obtained from the wind-swept, bleak and barren parts of the hills show that they have become burrowers with the development of concomitant structures and shape of body. Taking the structural alterations alone into consideration, we find that the forest specimens present marked deviations, and there can be little doubt that spatial extension bringing the entire armoury of the changed environmental factors into operation must have a considerable influence first in inducing minor adaptive regulations, which becoming further modified by the selective process, apparently tend to establish specific differences.

Now dealing with genetic modifications of *Rana cyanophlyctis* and *Bufo melanostictus*, the most conspicuous change is that in both the forms the number of eggs laid in the hilly streams (*Bufo*) and pools (*R. cyanophlyctis*) is definitely fewer. Further the eggs of the frog instead of assuming a lumpy shape and a marginal position of the tanks as in the plains, are laid in patches floating in the middle of the hilly pools more in the manner of Microhylidæ. Correlated with the diminished size of the ovary in these two examples, the growth of the fat-body undergoes a corresponding reduction. In the case of *R. cyanophlyctis*, the tadpoles taken from the plains have been known to attain a remarkably large size comparable with those of *Rana curtipes* and *Rh. pleurostictus*,—but large dimensions of forest tadpoles of this species are practically unknown. I have not, however, noticed any such changes in the case of the tadpoles of the forest toads, and all these tadpoles have greatly enlarged pouting lips, absent in the tadpoles of the plains. I have no account of the period occupied by metamorphosis. The reduction in the number of eggs is obviously an instance of physiological economy established by the absence of a comparatively negligible number of natural enemies of tadpoles, a relatively fewer number of which would suffice to maintain the proportion of the adult population in the amphibian fauna of the whole forest area.

I have traversed only the outer fringes of the ecological studies of amphibians and have dealt with only some of the minor problems. 'The study of the relation of organisms to the environment, and the devices they adopt in meeting the conditions imposed upon them by the world, and the interplay of processes within the specific groups and the processes occurring outside, must form one of the most romantic chapters of biology.' I hope that this aspect of zoological studies will become increasingly popular, for the problems presented in this field of knowledge possess interest to students, advanced scientists and speculative philosophers.

SECTION OF ANTHROPOLOGY

President :—D. N. Majumdar, M.A., Ph.D., F.R.A.I.

Presidential Address

TRIBAL CULTURES AND ACCULTURATION

Contents.

		Page
1.	Introduction	179
2.	Descriptive Account of Bastar State	182
3.	Ethnological and Linguistic Divisions	183
4.	Cultural Groups	189
5.	General Economic Life of the Cultural Groups.	194
6.	An indigenous Cultural Institution	199
7.	Origin of the Institution	208
8.	An Institution of Advanced Culture	211
9.	Symbiosis and Acculturation	218

Introduction.

As a field investigator, I have had the privilege of studying first-hand a number of tribes and castes living in accessible and inaccessible areas during the last twelve years. In all these investigations I had assumed more or less a monographic attitude so that like all monographists, I fixed my attention on a single culture at a single epoch of its existence and tried to delineate it with the utmost fidelity. I found this attitude extremely helpful as it revealed the subtler aspects of the culture concerned which would have been difficult to decipher had the culture been differently viewed. This is why almost all field anthropologists have written monographs and our knowledge of primitive social institutions is derived mostly from monographic studies of savage or semisavage cultures. We have in India some very important monographs on primitive tribes. Some of these, however, are extremely authentic as the authors of these monographs have taken immense care and pains to describe the traits of each culture with scientific accuracy. Such, for example, are the monographs on the Chota Nagpur tribes by Sarat Chandra Roy, those of the Naga tribes of Assam by Dr. J. H. Hutton and his colleague Mr. J. P. Mills and a recent publication by Mr. W. V. Grigson on the Marias of Bastar.

There is, however, one inherent defect in this monographic delineation of cultures, a defect which becomes increasingly vital as we proceed to describe cultures which have been penetrated by other cultures. The monographic method in amateur hands has invariably failed to separate the native warp from the foreign woof, and has failed also to evaluate the importance of the rôle of diffusion in cultural progress. In India most of the tribal groups have come in contact with higher social groups and rites and customs introduced from highly organized societies have blended with those of a primitive or infantile character. It is therefore, imperative that the monographic method, though highly scientific, should be followed with caution as the conditions under which the tribal groups live today have undergone tremendous changes. How far social life has deflected from tribal norms under pressure of alien cultures needs to be estimated before the picture of a culture may be complete. This has made me undertake a comparative study of the social institutions of a number of groups living in a particular geographical area, in order to estimate the rôle of cultural contacts in primitive social life. Analysis has shown how significant are the effects of such contacts, how social groups are adapting themselves to changed socio-economic conditions, also how maladaption is leading to tribal extinction or absorption into more dynamic and vital cultures.

In 1929, two years before the census of 1931 was undertaken, I made a first-hand study of the Korwa (Mirzapur) culture and for the first time I could realize the importance of cultural contacts on primitive races. In the district Gazetteer of Palamau, the Korwas are described as follows: 'In appearance they have a greater resemblance to the African Negroes than any of the Munda tribes, round faces, very black skin, large mouths, very thick lips and broad flat noses. They are short, thick set men with deep chests and broad shoulders giving the idea of great power, at the same time they are exceedingly active. Like all wild tribes they are very poor cultivators and subsist upon herbs and roots and the produce of the chase'. Such an active and powerful tribe much more interesting from the cultural point of view are the Korwas of Mirzapur who are distributed over the fringes of the Chota Nagpur Plateau and are at present a dying tribe with little or no ambition in life, scarcely getting a full meal a day and always at the mercy of moneylenders whose serfs they are for the debts of their forefathers as well as their own. I made an intensive study of the discomforts they were suffering from, and how they have responded to them but I could see that they were on evil days; they have been decreasing in number from decade to decade but today they have reached a stage when their disappearance or exit will soon become a *fait accompli.* (See my paper on Primitive Society and its Discomforts—Proceedings, 2nd Population and Family Hygiene Conference, Bombay, 1938.)

In an article on 'Race and Adaptability' in the *Journal of the Royal Asiatic Society of Bengal* (New Series), Vol. 25, 1929, No. 1, I wrote the following passage: 'If the rapid disappearance of the primitive tribes is one of the inevitable results of civilization and if it is due to the change from the unfettered life of the jungle tribes to a so-called ordered existence or a life of degraded serfs, which have been more or less responsible for a complete change in their mental outlook, it is all the more essential that the factors of this civilization should be analyzed and some sort of protection should be provided for in order to enable them to hold their own against the onslaught of foreign ideas'. I discussed in this paper the various factors which are responsible for maladaptation of the primitive stock and also showed how far groups can progress by a process of acculturation provided the impacts of cultures are not too violent. As the Census of 1931 was approaching, I made a special plea for a study of the effects of contacts of civilization on primitive groups.

In the questionnaire issued by Dr. J. H. Hutton, Census Commissioner of India, 1931, which was communicated to me by him, provision was made for such an inquiry. Some data were collected by the various Census Superintendents although it may be mentioned that the inquiry was not systematically followed up in every Province. Besides, the data were often collected through persons whose knowledge of primitive life and conduct was not very satisfactory, with the result that much still remains to be done on this subject. The results of this inquiry have appeared in special appendices to the Census Reports and furnish very important material for comparative study of conditions prevailing in different cultural zones. A similar and more intensive inquiry may be profitably undertaken during the coming Census so that not only the recent changes in tribal life could be known, but it may be possible to check the data already recorded in the previous Census. As there are more than 30 million primitive people in India, which is nearly half the population of Nazi Germany, it is necessary that we know how they live and feel, what are their discomforts and how they can be helped to tide over periods of crises, so that the administration concerned may take more genuine interest in their welfare. I should further suggest that instead of collecting data through untrained enumerators or the inferior staff of the local administration as is the usual practice, trained anthropologists may be appointed to do this work, and I should think that two or three anthropologists in selected areas, if they study these processes of adaptation and maladaptation intensively, the data will be of far greater moment than extensive inquiries carried through people whose knowledge of primitive conditions is of doubtful value.

In the present address, I propose to discuss the importance of cultural contacts, the effects of such contacts on primitive institutions, the various customs and traditions, primitive as well as advanced and how they have blended and the contribution of each of the cultural groups living in the culture area, to the formation of an interesting culture complex. I have selected for this purpose, the state of Bastar in the Central Provinces, where I worked during the last summer vacation and where I intend continuing my investigations in future. I should mention here, my grateful thanks to the administration of Bastar, particularly to the present Dewan, Mr. E. S. Hyde, I.C.S., whose keen interest in my work has made it possible for me to collect the mass of material I possess on Bastar. An anthropologist, if he wants to do any substantial work, must be in the debt of a large number of people, particularly the administration of the area where he sets to work, but he must be lucky indeed if he finds the administrative head of the area genuinely interested in the work of the anthropologist and such was my fortune in Bastar. The facilities that were provided by the state, and informations which the administrator and his staff particularly Mr. T. C. R. Menon, supplied me voluntarily, above all the courtesy that was shown to me and my colleagues, testifies to the generous sympathy the state has for its people. To my student assistants, Mr. Indrajit Singh and Mr. S. A. H. Rizavi, I owe a great deal, as without their help I could not succeed in exploring much of the interior parts of C.P. which we have done during a comparatively short period. Mr. Indrajit Singh has looked to the management of the tour and Mr. Rizavi has acted as photographer.

DESCRIPTIVE ACCOUNT OF BASTAR STATE.

Bastar is a large and important state under the Eastern States' Agency. From the report of Captain Hector Mackenzie, Secretary to the Chief Commissioner, Central Provinces, 1863, it appears that the state was originally an extensive one from about 235 miles from North to South and about 182 miles from East to West. By an earlier estimate its area was 20,400 square miles (170 miles from North to South and 120 miles East to West). The revised figures according to the survey of India, put the area as 13,725 square miles and it lies between 17° 46′ to 20° 14′N. and 80° 15′ and 82° 1′E. To the north of Bastar lie the Kankar state and the Dhamtari Tahsil of Raipur District, to the east is situated the state of Jeypur also under the Eastern States' Agency. The Godavari river forms part of the southern boundary of the state and the Chanda District lies to the west. The country is hilly and covered with forests. The central and north-western portions of the state are rugged and mountainous. A plateau with an elevation of approximately 2,000 ft. above sea level lies to the eastern part of the state running from north to south. Jagdalpur, the capital of the state, lies to the south of the plateau. The Indravati river which joins the Godavari after forming the southern boundary of the state, flows across the centre of the state from East to West thus partitioning it into two portions. The north-western is covered by a mass of rugged hills known as Abujmarh which affords shelter to the most primitive section of the population, *viz.* the Maria Gonds, better known as the Hill Marias.

The forests to the south-west contain some valuable teak but towards the north-east the sal replaces the teak. In the hills bamboo is luxuriantly grown which provides building material to the people of the state. The climate is damp and unhealthy during the major part of the year, the rainfall is 58′ 66″ while the temperature varies from 120° to 46°F. The density of population for the whole state is 35 persons per square mile and varies from place to place, from 4 persons or less per square mile in the hilly tracts to nearly 100 per square mile round about the capital of the state. The total population of the state according to the latest census figures is 5,24,721 of which 2,63,248 are males and 2,61,473 are females.

ETHNOLOGICAL AND LINGUISTIC DIVISIONS.

The native population of the state are known to belong to the Gond race. The foreigners and immigrants who have settled in the state are believed to have freely mixed with the native population. The order of social precedence in the state is as follows:—(1) Dhakars, (2) Halbas, (3) Kewats, and Kurukhs or Dhimars, (4) Kalhars, (5) Sundris, (6) Panra, (7) Gadabas, (8) Bhatras, (9) Parjas or Dhruvas, (10) Murias, (11) Marias of the plateau, also known as Dandami Marias, and (12) Hill Marias. At the bottom of the social ladder are the Hill Marias and at the top, the Dhakars. Of the remaining groups, Panra. Sunri, Kalhar, Rawat and Kurukh, are only functional, and are not numerically very large. Popular opinion ascribes these groups to indigenous origin and there is good reason too. The physical features tell their tale and except perhaps the shrewdness of their looks, there is little to distinguish them from the tribal population round about them. When these groups live in areas predominantly tribal, they still intermarry with the latter but where single families live they prefer to retain their identity by marrying their own kind. Some of the more important occupational groups who live scattered all over the state and have become substantial, possess traditional beliefs about their descent from concubinage between men of higher castes and indigenous women. The cultural differences between the various groups mentioned above, are not very sharp or well-defined and if we follow the order indicated above, the transition from one group to the other is indeed difficult to discern. But the groups at the extremes of the scale certainly differ significantly.

Although the language of the state is Halbi which is a mixed dialect of Hindi, Oriya and Marathi and is akin to Chattisgarhi which is spoken over wide areas in the Province, the inhabitants being mostly Gonds, speak the various dialects of the Gondi language. The different branches of this linguistic sub-family of languages are spoken by different tribal groups. Some of these tribal groups like the Marias of Abujmarh hills have remained isolated till today, and few cultural traits of modern times have penetrated into the inaccessible recesses of hills and forests. The Maria dialect has remained very much pure as it does not appear to have been influenced by the dialects of other more or less sophisticated groups.

The linguistic map of Bastar will show the zones into which the state may be divided. In the northern border of the state Chattisgarhi Hindi (Eastern Hindi) is spoken. The greater part of the eastern border has Oriya as its principal language. In the south-east some islands of Koya dialects are found which are very similar to Maria spoken in the state. Inside the state the Parjas and Bhatras speak dialects which appear to be derived from Oriya or very much influenced by it. In the south and south-west the language is Telugu while along the western border debased form of Marhatti is spoken by a number of scattered communities. The interior of the state is inhabited by various aboriginal groups who speak their respective dialects all affiliated to the Gondi, more or less influenced by border languages in accordance with their proximity to them or the intensity of their contacts with people speaking those languages. The only representative of the Munda speaking people perhaps are the Gadabas who are now a small occupational group palanquin bearers, living east of Jagdalpur and whose cultural life may be distinguished from the rest of the tribal stock though they are gradually conforming to the Halba cultural pattern we shall discuss below.

All over the state except the Abujmarh hills, the Godavari and the lower Saveri and lower Indravati valleys, Halbi is understood and is the verbal medium of instruction in schools. As will be evident from the linguistic map of Bastar, dialects and languages frequently merge into each other. As Mr. E. S. Hyde points out, most people of Bastar speak at least two languages. Where Halbi is shown alone, Muria or Gondi is also spoken so that the extent of bilingualism in the state is greater than what has been shown in the Census Report of 1931.

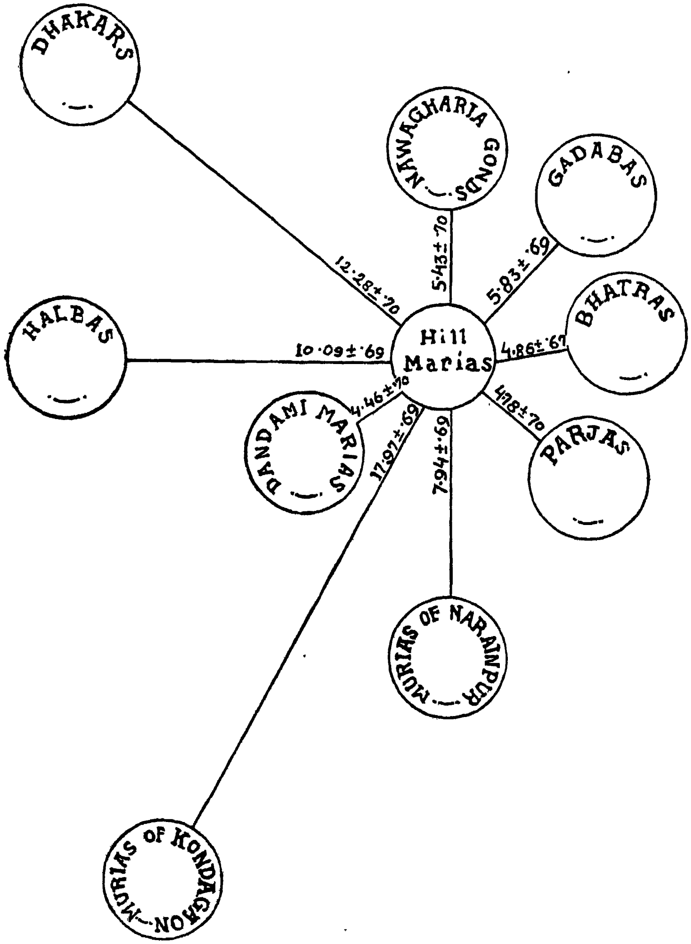
The linguistic map will show that the frontiers of language are very much uncertain and that one group has been influenced by the other. The same is the case with ethnic frontiers. Bastar has been for centuries a veritable melting pot of races and groups. A continual process of admixture has been going on and today all ethnic frontiers appear to have broken down and the various groups, tribes or castes inspite of their professions to the contrary, appear to have little of racial purity in them and are today cultural units in a great culture zone.

A comparison of the somatic characters of the various groups mentioned above based on 16 absolute characters, *e.g.*, Head Length, Head Breadth, Auricular Height, Nasal length, Nasal Width, Nasal Depth, Orbito-Nasal Breadth, Orbito-Nasal Arc, Bizygomatic breadth, Bigonial Breadth, Distances from Nasion to Crinion, Crinion to Menton, Total facial Length, Upper Facial Length, Stature and Span, give interesting results which may be diagrammatically represented as below. In the two text-figures are shown the reduced coefficients of racial likeness between 10 cultural groups.

The small values of the R.C.R.L. only show that the evidence provided by the data is insufficient to justify the assertion that the cultural groups are ethnically divergent. (Cf. R. A. Fisher, 'The coefficients of Racial Likeness and the Future of Craniometry', *Journal of the Royal Anthropological Institute*, Vol. LXVI, January–June, 1936.) The greater values of the R.C.R.L. do not prove a racial difference either. As Prof. Fisher points out, 'It is somewhat unfortunate that the name assigned to the coefficient of racial likeness does suggest to many who first hear of it that it affords a measure of the differences or inversely of the likeness, between different races.' Again the same author writes, 'In the case of the coefficient of racial likeness a second consideration should also prevent any attempt to interpret it as a measure of racial difference, for this coefficient is liable to be large if the series of skulls being compared differ considerably in any measurable feature, whatever that feature may be.' Prof. Fisher summarizes his arguments on coefficient of racial likeness as follows: 'That first criticism, then is that the name assigned has led to some misunderstanding of its function and possible use. The second is that as a test of significance it is not a very reliable one. The coefficient of racial likeness is defective in that it takes no account of the correlation and covariation of different measurements but treats them as though they are statistically independent. The effect of this is to cause very high or very low values of the coefficient to occur more frequently by chance than they should. This effect increases rapidly, both for statistical and for anatomical reasons, as the number of different measurements used is increased and may perhaps account for some of the great contrasts in the values of the coefficients which have been found.'

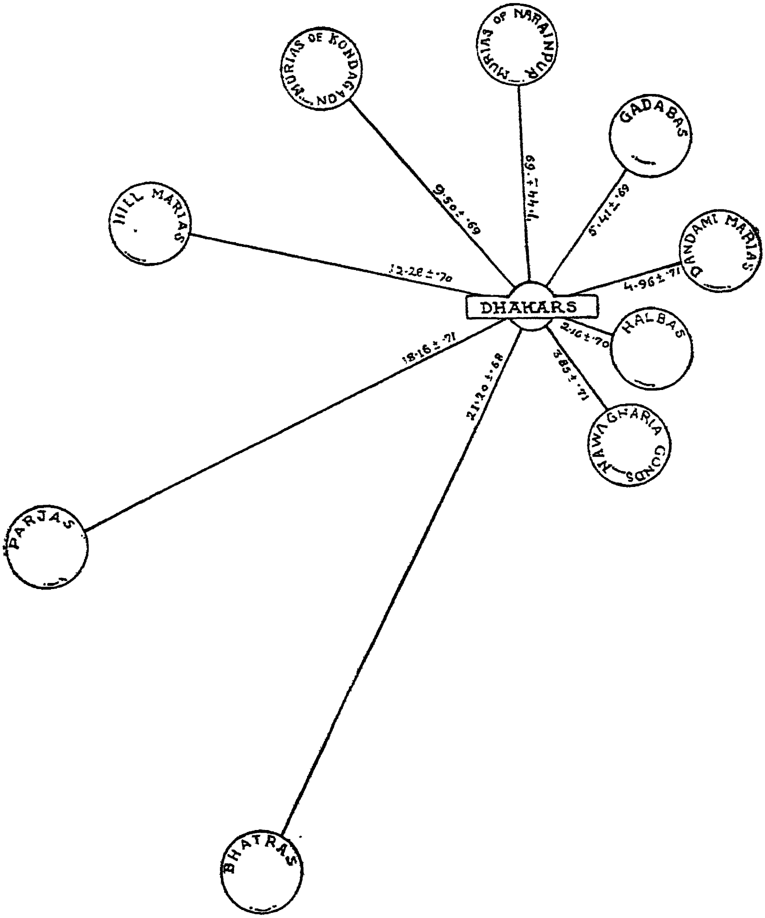
Dr. G. M. Morant who was one of the earliest to use the coefficient of racial likeness in anthropometry, points out the limitations of the C.R.L. method in the following words: It is not a true measure of absolute divergence and must not for a moment be considered as such. When it is said that a low coefficient between two races A and B indicates a closer relationship than a high coefficient between A and C, what is meant always is that it is more probable that A and B are random samples from the same population than that A and C are (*Biometrica*, 1923, XIV, 193–264). Without therefore claiming any finality on this question I am presenting my results for what they are worth.

As the Hill Marias are the lowest in the scale of social precedence the Text-Figure I will indicate the relation between them and the other cultural groups of Bastar. The Nawagharia Gonds do not belong to Bastar but they are included to show the affiliation of the Gonds of Bastar with those living in neighbouring areas.



TEXT-FIG. I.

The Text-Figure II shows the alignment of the different cultural groups with respect to the Dhakars who are the highest cultural group in Bastar.



TEXT-FIG. II.

If we take 0–3 as intimate association; 3–9 as association and above 9 as divergence (?), then we find that the Hill Marias have affiliation with Bhatras, Parjas, Dandami Marias, Nawagharia Gonds, Gadabas, Murias of Narayanpur but less affiliation with Murias of Kondagaon, Halbas and Dhakars. On the other hand the Dhakars have more association with the Murias of Narayanpur, Gadabas, Dandami Marias, Nawagharia Gonds and Halbas, than they have with Hill Marias, Murias of Kondagaon, Parjas and Bhatras. The relation between Dhakars and Halbas is very intimate. It may be suggested that the inter-relation between the various cultural groups in Bastar indicate an ethnic miscegenation and groups speaking the same or allied languages are more intimately related than those speaking different tongues. The Murias of Kondagaon, however, presents a difficulty and probably they are more mixed than the other groups. As the statistical data will be discussed in a separate paper I am only giving the tables of crude and reduced coefficients of likeness between ten groups already mentioned.

A comparison of the standard deviations of the large number of absolute physical characters measured by me does not, however, indicate any great intermixture in Bastar, for the standard deviations in the case of those groups which are known to have freely mixed with tribal elements are not appreciably higher than those we get for comparatively purer or even homogenous groups. In most of the characters, the Halbas show the highest standard deviations while the Parjas come next to the Halbas. This is expected as both the Halbas and Parjas are recruited from various tribes and castes and they represent only cultural patterns and not ethnic groups. Of the sixteen absolute characters measured from 10 cultural groups in Bastar, the Parjas show the highest standard deviations for six characters, and the Halbas for 5, while in the rest of the characters the Halbas and the Parjas share the second position in the list. While these data prove the greater variability of the Halbas and Parjas, it does not necessarily mean that the other groups are less mixed than the former, for the standard deviations for anthropometric characters from mixed groups become high or low in accordance with the nature of the blend. Thus J. C. Trevor who was my colleague at the Galton Laboratory in 1937 and who has been investigating into the social and biological effects of race crossing and have collected anthropometric data of a number of series representative of living groups of mixed descent from various parts of the world, finds that in every case for characters which clearly distinguish the two presumed parent populations, the average measurements of the one derived from them are intermediate in value. 'As far as can be ascertained', writes Trevor, 'from the best evidence available, the cross results in a nearly perfect blending of average values, determined by the proportions in which the parent populations have mixed.' These results are not perhaps genetically surprising if the parent populations are themselves highly heterozygous and variable. The variabilities of the crossed series, therefore, are not necessarily greater than those of the parent populations and if we pin our faith on the variability alone, to determine the purity or homogeneity of the samples, it will give us results which cannot be otherwise substantiated.

CULTURAL GROUPS.

The Dhakars are regarded as the highest in the social scale and are the reputed descendants of Kshatriyas who followed the ruling family to Bastar. They have taken to indigenous or tribal women and today there are various types of features discernible among them. The custom of 'Ghaita Pani' or family rehabilitation which was practised till recently but has now been abandoned, affords evidence of the anxiety of the ruling family to augment the number of the higher social groups in the state. Considering the small proportion of the immigrant population in the state and the desirability of increasing their number, the chiefs introduced a scheme of auction of widows in the state. As it always happens when an invading group comes and settles among the invaded, the difficulty of procuring wives becomes indeed great and where the indigenous women belong to the wild and savage tribes, this difficulty assumes a magnitude which cannot be effectively solved. Not content with making widow re-marriage popular among the higher castes, the Raja began to send out emissaries to discover where widows or divorced women of the four higher castes existed. These women were summoned to the headquarters of the *Tahsil* where they lived and were put up to the highest bidder care being taken to see that the buyer was of the same caste, though not invariably, as the women sold. Levirate was allowed and if the widow's brother-in-law wanted to keep her, he could do so by paying a small consideration to the Raja but otherwise the latter abrogated to himself the complete right to dispose of her to the highest bidder. In some cases, however, it was found that angry husbands used to approach the Raja requesting him to intervene in their domestic arrangement and wives who misbehaved or were guilty of sexual lapses were put to auction and sold as widows.

Next to Dhakars, the Halbas appear to be culturally a dominant group as the language of the state is Halbi and the supposed military antecedents of the Halbas give them an importance which is reflected in their attitude to the other social groups. True to the traditions of warlike people they have taken to women from the tribal groups and have not yet formed a '*Jus connubii*' so that their ranks are still open to outsiders. The example of the Dhakars has perhaps some lesson for them and thus the intermixture of groups has not been tabooed by caste prescriptions. The distribution of Halbas in Bastar shows that these people are scattered in the fertile tracts irrespective of the fact that they are surrounded by Murias, Marias and other tribal groups. In many places they form a top-dressing as it were on a solid tribal base. This has made it possible for the Murias and Marias to adopt many of their alien traits while the Halbas themselves have conformed consciously or unconsciously to the prevailing tribal pattern of culture. In Narayanpur, the few families of Halbas we have met and at other villages, *viz.*, Chindbahar, Badaingee, Tekraguda, Gumiapal, Kerageon where we measured the Halbas, the difference between them and the Murias, Marias, Dhruvas and Gadabas appeared to be indicated only in dress and slightly in material culture. In the matters of beliefs and practices pertaining to their social and religious life the Halbas still show the same superstitious regard for sorcery, witchcraft, fetishes, etc., and protect their persons against possible dangers by subscribing to herbs and simples with powerful charms muttered into them by skilful votaries of dreaded spirits believed to interfere with human life by their agile and nefarious ways. The Halba therefore, is not a distinct cultural group in Bastar, the designation does only mean the dominant cultural pattern which is an open one, and which is very much built up on an aboriginal foundation. The worship of Log-gods by the Halbas appears to be in conformity with the customs of the wilder tribes of the area. The complex cult of the mother goddess which has reached a stage of high elaboration among them and the segregation of menstruating women indicate, however, a reciprocal cultural relationship with the indigenous tribal population.

Except the Marias of Abujmar hills, all the other tribal groups are coming together as sharers of a common cultural existence. The Murias of Narayanpur are believed by some to be originally Marias of Abujmarh, but have settled down in the plains thereby abandoning much of their original traits unnecessary to their existence as plainsmen. There is, however, greater cultural similarity between the Murias of Narayanpur and the Marias of Abujmar than between the latter and the Murias of Kondagaon whom Grigson refers to as 'Gotul' Murias.

The Marias of Abujmar appear to be the wildest tribe in Bastar who still roam about in the dense forests and forage for food without much of an interference from the state. They have not yet entered the social economy or adopted the prevailing cultural pattern of Bastar. Those of them who have wandered into the plains and have settled down as permanent or semi-permanent cultivators are called Dandami Marias or Bison head Marias on account of their characteristic head-dress which is of bison horns made into a spectacular head gear used in dancing. This, however, may represent a totemic symbol though its origin is forgotten today.

The Hill Marias put on next to nothing on their person except strings of beads round the waist. The men go about almost naked with a piece of rag just enough to cover the private parts but their handsome physique, well-proportioned features, and gay disposition make them extremely attractive which compensates for their often disgusting nudity. The women wear fringed or unfringed narrow cloth round their loins but do not cover the portion waist upwards. The neck is covered with many rows of bead and metal necklaces most of which are locally made or are bought from the weekly market. The pieces of cloth or rag with which the women cover their loins are woven by themselves on primitive looms, the yarns are made partly from fibres of jungle shrubs and partly from cotton. Recently, however, these rags of indigenous make are being quickly replaced by small pieces of cloth which they buy from distant markets, or from itinerant traders who dare risk their lives to get into the Maria country. Even today the Marias and Dandamis are infamous for homicidal proclivities and the large number of murders on flimsy pretexts particularly among the latter make them otherwise notorious tribes in Bastar. The connection between these murders and magico-religious beliefs has not been definitely established but considering the method of disposal of the sacrificed animals and the popular stories so widely current in the neighbourhood it cannot be safely asserted that there is no connection between their homicidal tendencies and their magical beliefs regarding the importance of the head of the human victim and the blood that gushes forth, to the cause of their prosperity in the fields and their success in the forests. The vernal sowing festival of the Marias affords evidence of the magico-religious significance of sacrifices, for during the accompanying hunt, the shedding of blood of the animals slain is taken as a very good omen, for it is believed to predict a rich and bumper crop. The midnight sacrifice of hen or pigs by the *Perma* is extremely significant for it is then that each family hands over a packet containing seeds to the *Perma* who piles them in front of him on the ground. Then he pours the blood of the sacrificed animal on the packets to soak them well with blood. This packet of seeds is mixed with other seeds at the time of sowing and the efficacy of this process is seldom questioned by the Marias.

The Murias whether of Kondagaon or of Narayanpur appear to be plains Marias, for they possess almost all the traits that form the culture pattern of the Marias. Some of the more important traits have undergone significant modifications which they must due to changed economic environment, for the country of the Murias is situated on the plains as also on the plateau and intercommunication between the various sections of the Murias is more feasible than between the Marias and Murias. The difference between the Marias who have settled in the plains and Marias who still dwell in their mountain asylum is greater today than between the Murias who live on the plains and those living on the high plateau. For example, the Kondagaon Murias or Gotul Murias do not differ fundamentally from the Narayanpur Murias whom Glasfurd called '*Jhooriyas*' and Grigson '*Jhoria*' Murias. The Murias of Kondagaon possess an important institution locally known as Gotal Guree which has suggested the name Gotul Murias to Grigson but the Murias everywhere possess an elaborate Gotul or dormitory organization and partake of the same cultural pattern.

The Dhruvas form another cultural group in Bastar who are vaguely known as Parjas, a generic name which includes a number of small groups speaking Oriya but originally belonging to one or other of the tribal groups living in Bastar and the neighbouring areas. Thus there are Khondi Parjas, speaking Khondi and Oriya, Gadaba Parjas who speak Gadaba and Oriya both, Koya Parjas who are the same as Marias and Dür Parjas who speak Oriya. Adoption by a tribe or a section of it of the dialect of a superior cultural group widens the social distance between it and its congeners till it leads to complete dissociation of the group from the parent body. With adoption of the traits of the higher culture-groups, their claim to higher social status gets the seal of public approval and ambitious members of the tribe gradually drift to the new order and merge into it. Even now, these Parja groups can be readily identified with the original tribes they are recruited from in their physical features, but cultural differences have assumed serious proportions in some cases though the configuration of their cultural life has not been much disturbed.

Many of the customs and practices of the higher cultural groups whose language they speak now have been assimilated by the Dhruvas but their own beliefs and practices have not been abandoned though they sometimes are found in an attenuated form. Thus no longer do we find the marriageable girls of the village confined in the underground cell where young men desirous of matrimony were to join them at night and make their choice. Carefully careless they would leave their brass bracelets with girls of their choice, so that next morning the parents of the girls concerned could identify the Romeos of the village. But even now, the girls of the village gather together under some improvised leafy hut at the outskirt of the village for a few weeks before the Dusserah and young men of the village or those from neighbouring villages frequent the hut, dance, sing and woo their sweethearts till exchanges of gifts take place and the union is talked about in the village. This choice is then implemented by the parents of the young man who carry pots of liquor and rice to the house of the bride who have the option of receiving or refusing them. In the latter case the gifts are doubled and negotiations take definite shape.

Though premarital licence is freely admitted by the Dhruvas, girls after marriage have to behave and fidelity of married life is very much prized by the society. If the girl is expected to be faithful to her husband, the latter also has to pass a test of fidelity. In earlier days, however, before the relatives on either side, the girl would take a hot brand and apply it to the boy's posteriors. If the boy cried or shrieked in pain, he was considered no good and was dropped like hot coal. In one of the marriage functions among the Dhruvas, we noticed how this custom had taken a more complex form. The girl was seen to walk round the boy with other girls of the village at her heels and after three such rounds pushed the burning end of the brand into the ground thus partially extinguishing the fire. She then lifted it up to apply gently to the posteriors of the boy. The bridegroom was startled but did not yell, jumped but did not complain and the gay crowd watched the ordeal with intense excitement. The explanation of this custom was naive no doubt but natural as contact with their neighbours, the high caste groups has taught them the ways of the latter. The fire was meant as they explained to me, to protect the young man from enemies of all kinds and to dispel fear of the spirits as well as of the wild animals of the forest, to protect the crops and vouch perpetual fidelity of the couple.

The Bhatras are a little higher in social scale than the Parjas. They have a few sub-groups which claim distinct social status as a result of Hinduization. The Hinduized Bhatras put on sacred threads and consider those who still adhere to tribal prescriptions as inferior and thus have already closed their ranks to other tribes and groups. Today Bhatras who still intermarry with other groups have distinctly lower social status. The Bhatras and Parjas live by permanent cultivation and even where they live near the forests, they seldom practise shifting cultivation like Marias. But they appear to have profited by their experience in earlier days, for they bring the undergrowth from the forests and burn them in their extensive rice fields. The Bhatras are either Parjas socially advanced due to their contacts with the Hindus or they belong originally to the same stock as the Parjas but have immigrated into Bastar later than the Parjas. Grigson refers to the fact that Parjas are priests of the 'Gaon Devi' or village mother in Bhatra villages and concludes as follows: 'the indication is that the Parja is the original settler displaced later by Bhatras'; he further says, that 'the ceremonies preceding the great Pargana ceremonial hunts through the jungles near Darba at the head of the pass descending from the Jagdalpur plateau into Sukma, though most of the villages attending are 'Bison horn Maria villages, the Pujaris who officiate at the altar of bows and arrows are Parjas'. Wherever there are two or more successive waves of immigration, if the patterns of culture are the same or even allied, cultural miscegenation is likely to follow and thus the knowledge of the local spirits and godlings possessed by the original settlers is taken advantage of by subsequent immigrant groups and it is therefore no wonder that the Parjas still supply the priests to other cultural groups of the area, for they are usually better versed in the spirit lore as well as in the methods that could establish harmonious relations between habitat, economy and society.

GENERAL ECONOMIC LIFE OF THE CULTURAL GROUPS.

Most of the tribal villages in Bastar are self-sufficient. There is usually a family of blacksmith in the village or several villages may have one such artisan who supplies the small needs of the people. The artisan elements in the population of these villages do not seem to have a separate origin. They are probably recruited from the tribal substratum. For example, some Muria who was skilled in iron smelting and was adept in making iron implements may have been allowed to ply the trade of iron-smith and his descendants have taken to this occupation and form today the functional group known as iron-smiths. The iron-smiths in the Maria country not only possess similar physical features but speak Maria, possess the same clan names as the Marias and even intermarry with the latter. Similarly among many other tribes of the locality the artisan elements owe their origin to the tribal stock and still have kept their ranks open. Among the Saoras who are widely scattered in the Ganjam Agency Tracts and the Vizagapatam district of the Madras Presidency there are a few occupational groups such as the 'Arisis' who weave cloths for the tribe, the Kundals who make baskets and the Lohars who are iron-smiths. All these are Saoras by origin and still marry in the tribe, though from the cultural point of view, they resemble the artisan elements in other parts of the country. Some of these groups have, however, become independent and although there is no theoretical bar to marriage outside, they usually confine it within their group. This, however, suggests a plausible solution of the origin of caste. The caste system in its present form may be a post-Aryan development, but its essential characteristics which favoured its growth and persistence were most probably of tribal origin. The Kurukhs, Kewats or Dhimar who live by fishing in Bastar affords an example on this point.

The Kurukhs of Chitrakot are physically akin to the Marias; even trained eyes will not be able to detect any difference in their make up. Even now Kurukhs marry non-Kurukhs and the wild Maria girls may take the Kurukhs as their spouses. All tribes and groups in Bastar take to fishing as a diversion but its adoption as a permanent occupation by the Kurukhs and their use of rod and line in fishing and their divorce from land have widened the social distance of the latter from the Marias from whom they are evidently recruited. Yet these Kurukhs are indispensable to the social economy of the Maria country as they barter their catch in rivers and tanks for grain at customary rates.

The same may be said about the Rawats of Bastar. They are found scattered all over the country and their occupation is tending cattle of the people. They are usually paid in kind by the people but they also sell milk and its produce to travellers and administrative officers who may need the same. Rawats appear to be recruited from the tribal population, for there is hardly any difference between them and the population they serve. In the interior of the Maria country and elsewhere, where the population is purely aboriginal, the need of domestic servants for travellers and administrative officers of the state must have been felt and a particular family was selected and granted the sacred thread by the state so that it could be of use to the visiting public. A clean caste was created among the unclean aborigines and today they attend all villages where there is a Paikguree or if previous information is sent to them. Grigson has also pointed out that a large number of the persons returned as members of the Hindu functional castes, the graziers, potters, fishermen, weavers, blacksmiths and others, are in reality members of the primitive tribes speaking their language and only differentiated from them by their occupation. There is nothing in their appearance to distinguish these persons from other aboriginals, they follow their tribal religions whether enumerated as such or as Hindus.

A comparison of differences of means and standard deviations in terms of their standard errors, of two series of measurements on the Kurukhs and Hill Marias indicate very little divergence between the two samples. In comparing constants, a difference greater than two times its standard error has been considered significant. The constants for the means of 16 absolute characters when compared give all values less than 2 except in the case of one nasal measurement, *viz.*, nasal height which is 2·03. The nasal height is a very delicate measurement and such small difference in value may be ignored. In standard deviations also except for the nasal breadth (2·26) and nasal height (2·9) all the other characters do not show any significant difference. The standard deviation for nasal height among the Kurukhs is higher than that of the Marias for the same character showing a greater variability perhaps. But considering all the characters it appears that for all practical purposes the two samples (the Marias and Kurukhs) may be taken to represent the same population. The cephalic index of the Hill Marias is 74·2, nasal index 83·0 and stature 162·06 while corresponding figures for the Kurukhs are 74·5, 82·4 and 161·54 respectively. All these point to an ethnic similarity which has been already referred to from a study of indefinite characters of the two populations. The result, however, should be interpreted as extremely important as such comparisons may lead to the identity of tribal groups with castes thereby explaining the transition of tribes into castes.

The material culture of the people of Bastar is very simple indeed, and in spite of the cultural miscegenation we have mentioned above, the wants of the people are not varied. The usual tools and implements made by the local smiths are the plough-share, axe-blades, arrow-blades, etc., while the plough and wooden hafts for the axe as well as bows and arrows are made by the people themselves. The ornaments which decorate women are not all locally made. Some of the bead necklaces are imported stuff and even the armlets and rings are brought by itinerant vendors or are had from the local weekly markets. Beads and cowrie shells are also locally woven into garlands and often these are coloured from indigenous dyes by the women. Aluminium ornaments are of recent origin and are not made by the local artisans. Various kinds of ear-rings are used, many of which are of Japanese or German make, but the indigenous method of dilating the lobes of the ear has not fallen into desuetude. In the interior various forms of tattooing are still found and though it is difficult to trace any relation between the types of tattooing and totemism and other social practices, the belief in their efficacy is not questioned by the Marias and Murias. The Halbas and Dhakars do not tattoo but all other tribal groups take to some form of tattooing. The hair is tastefully decorated and white bamboo combs are used by women to make the coiffure look extremely pretty and attractive. Half a dozen or more combs usually of indigenous make, are put in rows on the coiffure and are very much prized by the girls, as they are usually presents from young men of the Gotul (dormitory) who are their admirers. These combs have a special fascination for a girl till she chooses to settle down as wife, when she has to content herself with the one which was presented to her by her lover and husband. As soon as the girls leave the Gotul permanently and this happens on marriage there is a waning of interest in the matter of dress and decoration and youth gradually drops its charm and attractiveness and surrenders to the exacting rôle of maternity and motherhood.

There is no industry worth the name in the state, the principal occupation of the people being agriculture and lumbering. The wild tribes are still accustomed to their nomadic life in the forests and supplement their gleanings there by crude cultivation. The usual method of cultivation is the *Dippa* which is the common form of agriculture practised all over the world wherever virgin forests abound. A piece of land is selected for the purpose, the trees are felled and the clearings are then set fire to. When the field is thus ready they dig holes and sow all kinds of seeds together or use very small or miniature ploughs for scratching the field and sow seeds broadcast. Sacrifices are then offered to the mother goddess and other godlings of the forest and also to the spirits of their ancestors, dances are held in their honour and when all these rites are done and none is omitted, they expect a bumper crop, sometimes two-fold, sometimes none at all. Before the seeds are dug in or sown in the usual way, some of these are ceremonially dedicated to the mother goddess who is also the goddess of corn, and the blood of the sacrificed animals is poured on the packet of seeds enough to soak it and to fecundate it as it were. On the forest clad slopes of hills whose declivity is not too steep for agriculture, *Penda* or a kind of terrace farming is practised. The method of cultivation is similar in both the cases, the fields in either case have to be left fallow for two to three years after every year of cultivation so that fresh growth of vegetation may be possible. Where water is available, arrangements are made to irrigate the fields by channelling water from higher levels, or more commonly the moisture of the soil is maintained by placing logs of wood or stones in such a way as not to allow the water from precipitation run to waste. Even then sacrifices are to be offered, dances have to be danced and the necessary vigil has to be kept during certain critical stages in the growth of the plants particularly when the crops ripen and the harvesting is on.

In areas where permanent clearings have been made the agricultural practices conform to the usual type met with in other parts of the country, though adequate arrangements for irrigation and manuring do not exist. Where knowledge of agricultural practices has been diffused and greater security of crops has resulted, the same incentive to sacrifices or magical practices does not exist and the elaborate rites and practices of the wild tribes have been replaced by thanksgiving services, such as is provided on the occasion of the ceremonial partaking of the new crop. But security of food supply has brought in more leisure and a multiplication of wants born of a new philosophy of life, so that wants that are unknown among the wilder groups have become real with consequent efforts to satisfy them. But insatiate wants like unfulfilled wishes have produced a social discontent. Competition though not so acute as yet, has replaced custom in some form and hunger of a few families for more land has ousted others from the moorings of their fields. On the other hand social and ceremonial needs have driven many to the arms of higher castes who have manœuvred to retain the services of these landless families to meet the increasing needs of farm labour.

When an aboriginal faces a need for cash either to meet the expenses of ceremonial marriage or to meet the obligations of the bride to her maternal uncle whose son should have been the legitimate claimant to the former's hand and who therefore should be compensated or when he is in need of money to pay some fine to the state or the village Panchayat and cannot raise it by selling the holding which is inalienable or by disposing of his personal belongings which are few, he takes a loan from a master under whom he might be working and agrees to repay it in the form of agricultural service. In days when the aboriginals lived in compact area and the tribal organization was integrated and strong the individual requirements like these were met by voluntary subscription as among the tribes of Chota Nagpur even today, bride-price payable in cattle is subscribed by the members of the clan or the village concerned. With the settlement of the higher social groups in the neighbourhood the individual members of aboriginal tribes have come in contact with the former either as suppliers of flowers or of small works of their own handicrafts or as drummers, labourers and bearers of palanquins. While tribal solidarity has suffered disintegration due to the possibility of existence independent of village community, the dependence of the individual families divorced from tribal occupations has been real so that their economic helplessness has become a source of their exploitation by the caste people. The idea of obligation and honesty, which these people have, make it impossible for them to leave the master's service, so long as they have not liquidated the debt and this may and very often means lifelong servitude. When the debt remains unpaid and the man dies, his son has to take up the burden of debt on his shoulders and continue as a *Kabadi* or lifelong servant in the master's family. The master very often pays a further advance towards the latter's marriage and thus the debts increase so that for generations the *Kabadi's* future and that of his descendants is mortgaged. Iniquitous terms imposed upon the *Kabadi* by his master and even continued ill-treatment and under-nourishment have not provoked any protest from the former who is wont to accept his lot with philosophic quietude. So long as he does not pay the debt and therefore serves the creditor, the latter has to pay certain remuneration which is expected to keep the *Kabadi* and his family out of starvation. The rate of remuneration varies in different Tahsils of the state. Besides the *Kabadi* there are in Bastar various kinds of servants whose relations with their employers vary according to the demand of agricultural labour and the customary rules prescribing their remunerations and conditions of service. There are the farm servants, for example, in Kondagaon and Bijapur Tahsils, farm servants do not take any advance from the master. In Bijapur, a small advance of Rs.3 to Rs.4 is taken, with promise to work for the agricultural year. Usually the servant gets a remuneration of Rs.4 to Rs.6 per year, 1 *paila* of *dhan* or 1 soli of rice, salt, chillies and tobacco daily and also one or two annas for liquor on festive occasions and two pieces of cloth worth Rs.1-8 in winter. In Konta Tahsil where the Jwari crop prevails, there is no such system of employing servants, those who are without land often help those who have, who pay some consideration at the time of harvesting. The *Pet-Posa* system which provides a relative or relatives in distress, allows the latter to live permanently in the house of a man, without any agreement as to service to be rendered or remuneration to be paid, and help the family in all its economic activities.

The *Kabadi* system, however, is mostly met with in settled areas and is less prevalent in areas where the aborigines live in compact groups or where the alien settlers have not penetrated much. The usual remuneration of a *Kabadi*, though subject to variation in different Tahsils, is as follows: 12 *khandis* of *dhan* per year, 6 *khandis* of '*Dandi mundi*' at the time of threshing and reaping, 6 *khandis* of *Kotar dhan* at the end of the harvest, cash remuneration of Rs.2 per annum, clothes Rs.1-8, salt, etc., for about 8as. and food at odd times. If all these are regularly paid it comes to Rs.2 per month on the basis of prices prevailing now, but as everything depends on the sweet will and pleasure of the master concerned, the situation sometimes degenerates into ruthless exploitation by the employers concerned. The *Kabadi* has to live in small outhouses, within the compound of his master's house and should be within hearing distance from the family.

Vigorous attempts have been made from time to time, and are being made by the present administration to eradicate the evils of the *Kabadi* system and it has been declared illegal in Bastar this year. But it is at best doubtful if the general release of the *Kabadis* has solved the problem of the *Kabadis*, for agrestic serfdom in some form or other is bound to remain where the possibilities of independent existence are limited. As land is available in plenty and the state is not callous to their interests, gradual settlement of these *Kabadis* on new lands will be possible but the *Kabadi* system shows how different social units living in the same cultural environment develop a relation of interdependence so much so that the existence of one group without the cooperation of the other is threatened and often end in maladaptation.

AN INDIGENOUS CULTURAL INSTITUTION.

Of all the interesting social institutions among the people of Bastar, that of Gotul or dormitory is the foremost as it is the pivot of social life where it is found and has even obscured the indigenous tribal and clan organization. The dormitory institution is found widely scattered among primitive peoples. It is met with among most of the aboriginal tribes of the Chota Nagpur Plateau, *viz.*, among the Mundas, Hos, Oraons, Birhors and Tamarias, among the tribes of the Central Provinces, among the Bhuiyas, among the Saoras of the Ganjam Agency tracts, among most of the Naga tribes of Assam, the Aos, the Semas, the Angamis, the Changs, the Lhotas, the Konyak tribes of the Naga hills, the Kukis and some of the tribes of Indonesia. The Mundas and Hos call it 'Gitiora', the Oraons call it 'Jonkerpa', the Bhuiyas 'Dhangarbasa', the Gonds know it, by the term 'Gotalguree', the Aos and the Semas call it 'Morung', the Memis have two names for it, the boys' dormitory is known as 'Ikhuichi', while the girls' is termed 'Iloichi', and the Angami call it 'Kichuki'. All young bachelors of a Munda village or *tola* as it is called have a fixed common dormitory in the house of a Munda neighbour who may have a hut to spare for the purpose. Likewise the girls of a village sleep together in the house of a childless old Munda couple or in the house of a Munda widow. The girls are taken care of by an elderly matron of the village who exercises a general supervision over their morals. the bachelors of an Oraon village must sleep together during night in the *dhumkuria* which is generally situated on the outskirt of the village. There is also a separate house for the girls where the latter pass the night under the guardianship of an elderly duenna. In case a house is not available for the purpose, the girls are distributed among the houses of widows. The Hos also possess two houses, one for the unmarried boys and the other for the maidens of the village. But in many villages, the custom is to distribute the girls among the houses of widows.

Many Gond villages in Chattisgarh and the feudatory states have a large house near the village where unmarried youth and maidens collect and dance and sing together at night. Some villages possess two, one for the boys and one for the girls. The Bhuiyas have the same system as the Oraons. The bachelors of the village sleep in one large house. Col. Dalton mentioned some villages having a house for maidens which they occupied without any elderly matron to look after them. The unmarried girls of the Aos sleep in small houses built for the purpose in twos and threes and the unmarried men sleep with them. Among the Lhotas, every Khel (division of a tribe) possesses one common bachelors' house or *Morung* and many of their customs and practices are associated with it. 'It is the sleeping place of every Lhota boy from the time he puts first his dao-holder till he marries, the rule being only relaxed in the case of boys who are allowed to remain at home and nurse an ailing and widowed mother, or when the house is no longer habitable.'

Among the Angami Nagas, however, the Morung is not always resorted to by the bachelors but is used on occasions of ceremonies and '*gennas*'. In some Memi villages the girls share the same dormitory as the young men. The boys sleep on an upper platform, the girls in a lower. The Murias and Marias of Bastar possess sleeping barracks outside the village, where boys and girls meet nightly to play and dance and sing till they fall asleep. The Marias have a Gotul in every village but the boys and girls do not always share the same house as among the Murias of Kondagaon. The Gotul institution appears to have developed to perfection in certain Muria villages where it has effectively superseded the tribal or clan organization. In the Muria Gotuls the boys and girls who share the Gotul are not all of the same clan and unions of boys and girls when they develop into permanent friendship may end in marriage if necessary. This is possible because both among the Murias of Narayanpur and those of Kondagaon, among whom the institution is very highly developed the villages are not scattered like those of the hill Marias and several clans share the same village or different wards of the same village. Originally the Gotul was a communal village dormitory used mainly by bachelors but at times by all the males of the village, and used also as a men's club.

The officers of the Gotul are many and their duties varied. The names of the officers are sometimes borrowed from the titles of Zemindari servants. In Padalibhum, the head boy of the dormitory is always known as the *Leyur Gaita* and below him the Gotul officers are the Leyur Majhi, the Jaliarsi, the Laharu, the Baidar and the Kamdar (cf. Grigson, the Maria Gonds of Bastar). The head officials of the Gotul in Narayanpur are as follows: Salau, Baidhar Siladar and Kotwar. The Salau is the chief of the Gotul. He is responsible to the elders of the tribe or village for all that happens in the Gotul. He orders dances and determines the dates and times of social functions and controls the other officers of the Gotul. Baidhar looks after the collection of fuel, cleaning and sweeping of the Gotulguree. Siladar is responsible for the attendance at the Gotul, he has to keep the inmates of Gotul informed about the programme in the Gotul and to report about their behaviour to the Salau. The Kotwar does the work of bailiff and has to call the members both male and female whenever the Gotul functions are ordered by the Salau. The Salau has certain definite privileges allowed by custom, as, for example, he can love a particular girl and declare it in public. The girl of his choice enjoys certain privileges which are denied to other girls. So long the Gotul is informed of his choice, no male member of the Gotul has a right to approach her or make love to her. The Salau has also the further privilege of having as many girls as he desires to keep about him. So long as the chief of the Gotul does not marry he remains in sole charge of the Gotul institution but after marriage, a new Salau is elected. The election of course must be unanimous. A Gotul member after marriage is not welcome in the Gotul. In case a married member frequents the Gotul, there is no tribal law forbidding his entry or his participation in Gotul life. The chief of the Gotul can only request him not to frequent the Gotul but in case the latter does not abandon his intentions, the Gotul brotherhood take recourse to certain conventional methods which ultimately bring about the desired effect. First, some member of the Gotul will be deputed to steal a fowl from his house, then a second one, a third one, till all the birds are stolen from his pen and eaten up by the Gotul brotherhood. If that is not enough, pigs, sheep and even cattle will share similar fate till depleted resources lead to domestic quarrels between husband and wife so that either he has to sever his connections with the Gotul or face divorce proceedings before the tribal council.

While married people are not allowed in the Gotulguree, special consideration is shown to the widows and widowers who want to share the Gotul, for there is no restriction against such persons and in one Gotul in Narayanpur the Salau was actually a widower, who confided to me that he had no intention of marrying again. The position and prestige of the Gotul girls are determined by the age and importance of their associates, but the Salau's mate wields considerable authority over all the girls of the Gotul and powers and privileges are often exercised by other girls in accordance with seniority and also according to their influence with the Gotul officials.

The unions of Gotul mates as well as those between Gotul boys and non-Gotul girls or *vice versa*, are not regarded as complete unless the couple after marriage spends a night with the Gotul fraternity. It is on this occasion that the Gotul ceremonially mourns the loss of the Gotul companions and formally acknowledges the transfer of loyalty of the newly married couple from the Gotul to the village which henceforward claims their undivided allegiance. This night generally witnesses a battle of wits between the Gotul fraternity and the village represented by married couples, in which the married or the mature group is subject to various criticisms for acts of omission and commission.

The Gotul organization has a tremendous effect on the social life of the tribes concerned. It is not only a club where the two sexes cooperate to direct their energies through productive channels, but it is here that the necessary training for the duties of tribal manhood is inculcated through a system which has the sanction of traditional experience. Training in discipline is an important feature of Gotul organization wherever it exists. Thus among the Oraons of Chota Nagpur there is a regular system of fagging in the dormitory. The smaller boys serve those of larger growth, shampoo their limbs, comb their hair and so on and they are subjected to severe discipline to make men of them. Where the boys and girls share the same dormitory as among the Murias of Bastar, the part of the small boys is played by the girls. As soon as the girls enter the Gotulguree after supper and they have to attend regularly every evening, they are to bow to the Gotul chief after which the girls take the boys, comb their hair and massage their hands and arms to refresh them. They then sing and dance together till late at night when they get tired and return to their homes chaperoned by their friends.

Where the Gotul organization is perfect as among the Murias, it is more or less independent of tribal control and the assistance of the Gotul can be had by the village on payment of certain specific fees, agreed mutually by the Gotul chief and the villagers in need of such assistance. In case the headman of the village needs the services of the Gotul boys, the chief of the Gotul is called on for help and this of course is ungrudgingly given, but individual villagers must pay for their services. Among the Marias where the Gotul is not so elaborately organized, the Gotul boys are only fed by the families who may require their services and no wages are paid for their labour. Tribal life in India as elsewhere is characterized by an absence of a hierarchy of economic organization. Absence of a well-assessed division of labour in primitive society does not favour the development of hereditory skill or technique which leads to the formation of artisan classes or guilds, so that spontaneous cooperation in domestic and economic life becomes essential. The dormitory house therefore affords the training ground for educating the children of the village in all matters relating to social and economic life of the tribe, so that they may participate in all activities of social or economic order.

Life in the dormitories is difficult to depict, for the risks involved in such inquiry and the jealousy with which the inmates guard the secrets of dormitory life make it sometimes physically impossible to know much about it. The dormitory house is usually situated in the heart of the jungle among the wild tribes or away from the village as in Bastar, so that except the inquisitive investigator, no stranger may stumble into it. It is purposely kept closed on all sides with only a small hole serving as door through which one can just crawl in and out. The inside of the room is dark or filled with smoke most of the time the room is in use, and little is visible from outside. Besides, the dormitory fraternity are under the severest penalties bound down to secrecy in regard to all that passes in their dormitory and even girls are punished if they dare tell stories. They are not allowed to join in the dances till the offence is condoned and it is the severest punishment that can be imagined by a girl. The girls will withdraw as soon as questions regarding their dormitory life are put to them. In most of these dormitories, publicity of any kind by the inmates is an efficient bar to participation in the nightly programmes. The social solidarity found in the dormitories reflects to a great extent on the tribal life and this perhaps accounts for the spontaneous discipline that characterizes the conduct of primitive life.

In his account of the dormitory life among the Murias and Marias of Bastar (*vide* Grigson, Maria Gonds of Bastar, Oxford University Press), Grigson writes as follows:—'Boys and girls of an age to visit the dormitories are known as Leyur and Leyas respectively. All the boys assemble at the dormitory in the evening for dancing, games and social and sexual training, sleeping on there after the departure of the girls to their homes late in the night. The girls attend at the dormitory in the evening, each girl being paired off with a boy of an 'Akomana' clan. The girls have to comb their boys' hair and massage their arms and legs, to dance with them and to be initiated into the mysteries of sex with them. Marriage frequently follows these dormitory unions, but by no means always does.'

Our investigations show that the mating of boys and girls in the dormitory is not so deliberately done as is described by Grigson. We discussed with the members of various dormitories in Kondagaon and Narayanpur, if the girls have to attach themselves to particular boys in the Gotul and whether the Gotul chief has to see that this mating is between persons of 'Akomana' clans marriage with whom, if necessary, is not barred by the rules of clan exogamy. We were told that such arrangement was not possible as the strength of the two sexes depend on the resources of the village. Any such convention would be a serious infringement of personal liberty and would militate against the prevailing practice which allows sufficient latitude to the sexes to select their partners in life. On the other hand, we were told that it was the unwritten code of conduct in the Gotul for a girl not to bestow her favours in public to any individual, for that would be coupling her name with some boy who may not be ultimately her partner in life. But this does not mean that the girls do not have their sweethearts, there is not a single girl whose eyes are not fixed on one or more of her acquaintances of the other sex, but she generally conducts herself in such a way that no other member of the Gotul gets an inkling of her intentions during the early overtures. This is why every evening a girl usually selects a new friend, massages him, combs his hair, and looks to his comforts. Even if she remains with the friend of her choice, she does not grudge doing odd bits for other boys who may need her assistance, so that no suspicion may arise about her choice.

Lessons in the various agricultural operations, in hunting, in honey gathering and other minor economic pursuits are imparted in these Gotuls through mimetic dances depicting them, while ideas about the sanctity of tribal discipline, social approbation, social justice, reciprocity of obligations, law and order in society, as well as relation between efforts and rewards between crime and punishment, are inculcated through stories and anecdotes which graphically describe individual doings and their repercussions on the social life of the community. Sex training is regarded as an indispensable discipline in dormitory life and various methods are adopted to give the inmates a knowledge of sex and sex practices. The central post of the Oraon dormitory which serves as the trunk bearing the slit for sexual exercise is not met with in the Muria Gotuls but the same objective is achieved by mimicking sex acts or by appropriate songs and rhythmic movements of limbs during dances and through anecdotes describing the methods and processes of the sex act and its importance to tribal life and conduct. Sexual act, however, is not taboo in the Gotul and does take place under cover of darkness. The officials of the Gotul organization often take advantage of their position and indirectly assist in the training of the novice and the non-initiate. The girls usually resent the actual act being performed in presence of the Gotul fraternity.

The popularity of a Gotul depends upon the personality of Gotul boys who can attract girls to the Gotul. In many big villages among the Murias there are several Gotulgurees in close proximity to one another and there are rivalries between the various fraternities for attracting the girls of the village. This is possible if the girls get sufficient attention from the boys and if the interests of the girls can be maintained by the personality of Gotul officials and the ingenuity of the boys in providing variety entertainments for the girls.

In one of the Gotuls in Kondagaon Tahsil, one dark night at about 1 A.M. we shot a torch through the small entrance and we found three groups in three corners of the big house, each consisting of 6 to 10 persons. Closer inspection revealed the composition of the groups. In one corner a young man about 20 years of age was lying on his back and six girls ages varying from 14 to 20, sitting or reclining round him, three to his right and equal number to his left all eagerly listening to his recent exploits as we were told afterwards. The youngest girl was massaging an arm, while the eldest one was caressing the hair of the boy, while the rest were reclining with their heads touching the sides of the young man's body. The flash of the light had the immediate effect of making the girls conscious of their uncovered body which they started setting to order. In another corner, two young men were surrounded by five elderly girls, most of whom had passed their teens and all discussing with great concern a case of *Armirtur* or elopement. A Gotul girl had eloped with a young man of her choice; her father wanted her to marry her cousin, maternal uncle's son, the preliminaries were gone through but the girl did not approve of this union. She had already expressed her opinion to her comrades in the Gotul, her parents were informed but they did not view it seriously. The relevant facts of the case were being gathered by the Salau from the elderly girls who appeared to know much about the case. The third corner was occupied by several boys of ages varying from 15 to 20, some lying on their backs, others sitting while two girls were sandwiched between two boys, who had their hands round the neck of the girls. This corner was most noisy and peels of laughter from the girls and loud conversations of the boys could be heard as we approached the Gotul. Nothing that we saw was suggestive of any licence in sex relationship but the interesting grouping that we discovered in the Gotul throws light on the organization of the Gotul fraternity.

There are age grades in the Gotul. The fraternity is divided into groups based on age and although the mean age of the Gotul fraternity we investigated was 14·9, there were as many as 5 grades into which the 39 inmates were distributed. Besides these age grades there were also sex grades and girls usually kept together unless there were unusual attractions to separate them. When a girl is asked to join a particular group of boys she manages to persuade some of her friends, so that a single girl is seldom found in any of these groups. Girls usually sit together or join the boys but rarely they pair off with boys. Outside the Gotul also, we found similar groups sitting by the side of fire in which both the sexes were equally represented. In one group three girls were massaging a boy, who, we were told, was the last arrival in the Gotul and thus was receiving the attention of the Gotul girls, all others evidently have been treated previously.

The distribution of work by the Gotul officials was, as admitted by them, on the basis of this age grading in the Gotul and every age grade was aware of what its members were expected to do, whenever their services were requisitioned by the village or their labours needed for the Gotul itself.

The relations of a Gotul girl with her family so long as she remains a member of the Gotul are of secondary importance to her and although she has to do some routine duties for the family to which she belongs, her interest centres round the life and activities in the Gotul to which she is a willing participant. Her allegiance to the Gotul often militates against her larger interests of family and village solidarity, but the strict discipline of the Gotul with its lure of amatory life puts a severe strain on her loyalty to her family and familial obligations. But the other aspect of this double allegiance is of very great importance to the clan or tribal solidarity, for the interests in children which parents must necessarily have, and the affections they possess are not centred on their own children only, but extend to children in general and the Gotul which to the village is a symbol of clan manhood receives the fostering care of the village. Quarrels often arise among the inmates of Gotul which may assume serious proportions and the arbitration by the Gotul officials may not satisfy the parties to the dispute but seldom such cases involve the parents of the children concerned.

The Gotul institution is found in a state of high elaboration among the Murias of Kondagaon and those of Narayanpur, it is practically absent among the Parjas, Gadabas and other tribal groups whose social position is superior to the former. It is present in a less complicated form among the Dandami Marias and in a rudimentary form among the Hill Marias, both of which are culturally inferior to the Murias. The Parjas and Gadabas have some common houses where the young men of the tribe find shelter during the night, but there does not exist any arrangement or organization among those who share the same roof. The Marias as we have already mentioned, possess the dormitory institution but it exists in embryo only. The dormitory among them is a men's club, where the able-bodied hunters sleep at night and the unmarried girls visit the young men, if and when they like. When the men are engaged in agriculture and sleep in the corn houses particularly when the crops ripen, the dormitories are either closed or inhabited by idlers and those whose services are not needed by the families to which they belong, it being the usual custom among the tribes for the senior male members to sleep in the corn houses.

The Gotul organization does not appear to have anything to do with sexual segregation, for such segregation is not usually found in those tribes possessing dormitories. Besides, most of the tribes which practise this institution allow sufficient liberty to the women and slips of morality so long as they are confined to the tribe are scarcely heeded. The facts we have already detailed above show that the dormitory fraternity is composed of various clans, marriage among whom is not barred by tribal or clan laws. Thus the necessity of sexual segregation is hardly enough to explain the origin and continuance of the institution.

The relevant facts which have bearing on the origin of this institution are as follows :—

(1) The distribution of this institution among hunting and nomadic tribes is extremely significant.

(2) The need of protection of the tribal group from the ferocious denizens of the forest as well as from the alien and hostile groups who may prey upon them for women or cattle or for both. The ablest hunters of the tribe had therefore to keep together for this purpose.

(3) The need of keeping awake during the night or major part of it for purposes of protection. These people usually take rest in the early hours of the night and during the day time which make possible the dormitory life with its nightly bonfires and its varied programmes of fun and festivities.

(4) Sex acts are usually tabooed during the busy agricultural season when men work strenuously in the fields or go on ceremonial hunting in the forests, the women therefore have to keep together for some periods of the year as any violation of this taboo has disastrous effects on the economic life of the family and the social group.

(5) From the time new crops shoot into corns and till the harvesting is over, all the men sleep apart from their wives in their fields while the latter sleep in the village. This also leads to the compulsory segregation of the sexes.

(6) Husbands, for example, among the Marias and Murias, are not allowed to sleep in the house with their wives so long as the navel cord of the new born child does not fall.

(7) Wives have to live separate for three to five days either in the communal hut or any special one provided by the family during the period of menstruation when it is taboo to see men and associate with anybody not so polluted.

(8) Sexual relationship is not allowed between husband and wife during the first few years after child birth or till the child weans.

(9) As Grigson writes, 'the Hill Marias are still doubtful about the propriety of men sleeping in the house or regard the jungle or some place overshadowed by the thick leaves of the Siari (Bauhinia Vahlie) creeper as the right place for intercourse between man and wife,' there is a prejudice among many primitive tribes to have sexual intercourse with wives in their houses. It may be either due to a belief that the god of prosperity or the ancestral spirits get annoyed or to the fact that the shades of the ancestors are usually sheltered in the house or a part of it, so that sex act performed in the house would have the same effect as doing it in public. The sanction for this custom may be traced to the belief that such irregularities result in damage to crops by pests or in the complete loss of yield and general calamities such as excessive precipitation, inadequate rainfall, diseases of cattle and crops and the various epidemics which claim their toll from the people.

(10) Most of the hunting communities which possess the dormitory institution are very sparing in the construction of houses. A family usually possesses one hut which may be partitioned to accommodate cattle or for housing the ancestral shades. Husband and wife sleep in one room with immature children and when these grow up they need to be removed and wherever the dormitory house exists, they are conveniently housed in it.

ORIGIN OF THE INSTITUTION.

It has been a fashion with some anthropologists to trace the origin of institutions to simple beginnings, and also to a single source. This monogenist attitude the anthropologist appears to have inherited from the biological sciences in which anthropology is deeply rooted. Recent researches do not prove the legitimacy of the monogenist view of evolution as it has been found that when history began men found themselves already possessed of those characteristics of skin, colour, hair form and the shape of the head which serve as the marks of race. The fossil remains of man that have been found in various parts of the world and the handicrafts of extinct types of man during the last one century afford tangible evidence of the antiquity and diversity of the human family and of the range of its earlier migrations. If such is the case for the hypothesis of monogenesis in the sphere of organic evolution, its application to cultural evolution has to be watched with greater vigilance. Most of the anthropologists of the historical school have held monogenist views regarding the origin of social institutions and it is this that has rendered their explanations of dubious value. The functional school of anthropology owes its consolidated position today to the failure of the monogenetic historical school in interpreting cultural origins, as field investigations in selected areas under controlled conditions have raised issues the solutions of which could not be arrived at on the basis of single origin.

The origin of an institution, a custom or a religious rite may be an accident, as inventions usually are, but the complicated machinery of social formation that we have inherited today has gathered its complexity and momentum in course of its career. A group may take an animal or plant name to designate itself, another may be known to trade or live on a particular animal or plant species by which it may be known to the outside world, an individual may take as his or her guardian angel an animal which might appear to him or her as a protector in dream, a woman may name her son or daughter after the animal which she believes to have mysteriously fecundated her, but the complex institution of totemism we find among many social groups owes its complexity to many traits whose identity is difficult to distinguish today. It does not matter how or what accident was responsible for the origin of an institution, in most cases it is a minor incident in the life of an individual or that of a human group, but it is essential to know how the institution has grown, how the different elements of the traits-complex have been grafted to the original trait stem. Once a particular idea or a custom is introduced by an individual and is adopted by the social group for utility or for spectacular effect, 'it would be kept alive and strengthened by ideas and sentiments not in themselves adequate to start the custom'. Such is the case with most of our social institutions.

The principles which underlie the survival of social institutions are indeed numerous. An institution, if borrowed from an alien source, remains for a time unchanged. The people who borrow it can easily adapt themselves to the institution as the borrowers need not enter into the spirit of the institution but can depend upon mere imitation.

A cultural trait borrowed or indigenous, remains unchanged if it cannot be fitted into the existing structure of the society or if any change in form leads to maladjustment. Again an institution may be put to several uses. So long as it subserves a number of purposes, its position in the social life of the community is readily conceded but as soon as it is found that the trait or institution does not fulfil the interests which it used to do, it loses its hold on the social life of the group concerned.

An institution, as I have said, may be introduced by accident. The belief in its efficacy may keep it alive in an unchanged form. Interest in it deepens if it can be put to more and more social uses. The larger the number of social contexts into which a trait fits in, the greater the number of interests it fulfils. The survival value of an institution is proportional to its utility as every cultural form is an instrument of adaptation. Its rôle is to render the process of adjustment of the group to its milieu as also of the intra-group adjustment, smooth and easy.

The longevity of a trait therefore rests upon a number of interests that it stimulates. When again, some of the interests that are usually answered in an institution may not find satisfaction in the accepted form or when a new object or trait diverts the attention of the group from the cultural form, it decreases in popularity and disintegrates altogether or remains in an attenuated form. Thus an institution may survive through the *principle of graded utility.* This is how the dormitory institution among the tribes of Bastar we have discussed above, has survived.

The dormitory is a group organization. Its origin may, as we have already referred to, be traced to the campings where the ablest hunters of the community took their shelter for purposes of defence and protection of the weaker members but in course of time other traits have slowly been woven round it and the elaborate Gotul of the Murias is the result. With settled life and a better control of food supply, predatory excursions of neighbouring groups for women or for cattle become rare, but economy of accommodation in the house, helps to maintain this communal organization as the members find it a convenient place where to sleep in and a venue for their communal activities. Association of men and women in the dormitory helps to make the group life vivid and concrete. Opportunities for intercommunication between the members of the group set up a group standard of social life and the effects of a deviation from the group are seen more in their proper perspectives. It is in the dormitory that a system of discipline may be rigorously tried and the success in this direction has contributed not a little to tribal and clan solidarity and apparently slavish compliance to traditional usages as we find in most of the primitive groups. Training of boys and girls in the usual economic pursuits characteristics of the group, in social and ceremonial duties, in sex and associated matters, is inculcated through the dormitory organization and thus fulfils an important rôle in the tribal life of the community concerned. Above all, the dormitory institution where it exists, insures tribal endogamy by controlling the movements of women within the tribal area and prohibiting social intercourse between men and women belonging to different tribes. How far this has been achieved depends on the effectiveness or otherwise of the dormitory organization.

AN INSTITUTION OF ADVANCED CULTURE.

(The Dusserah Festival.)

The Dusserah festival on the other hand has a different tale to tell, for it has been introduced by the ruling family and participation of all tribes and castes of the state is regarded as more or less obligatory. Tradition has it that the family goddess of the founder of Bastar family was Dhanteswari who appeared to him in dream and advised him to flee from Warangal where the Mohammedans had pursued him. Annam Deo, for that was his name, followed the advice of his family goddess and fled from Warangal. After traversing a long trek through inaccessible areas abruptly stopped on the other side of the Pairi river which forms today the boundary between Kanker and Bastar states. The hereditary high priest of the temple accompanied him, so also some representative Rajput families. With them was brought the sword of Dhanteswari which in the new shrine dedicated to her in Bastar, provides the symbol of the goddess and even today the sword is worshipped in the Dhanteswari temple in Jagdalpur.

The Dusserah festival is held in honour of Dhanteswari and except perhaps the Marias of Abujmarh, all other groups participate in the festival. The ceremony, however, continues for 15 days and on each day there is a new programme. The peculiarity of this celebration is that it has brought together the various cultural groups in Bastar as sharers of a common heritage, for even the lowest of the castes has not been denied its share in the communal worship. Along with Dhanteswari a host of lesser powers and spirits, some indigenous, others borrowed, such as Patdeo, Keshadeo, Jangdadeo, Hinglamata, Pardeshinmata, Barimata, etc., are prayed to and propitiated by the people, which, however, bring animistic tribes and the many Hindu castes in a common religious fold.

The Maharas, a Hinduized caste yet untouchable and impure and weavers by profession, infamous for witchcraft and sorcery, but whose importance to the people of the state cannot be exaggerated as the state does not possess a net-work of communications or markets supplying the simple needs of the people at large, are given a very distinctive rôle, for it is they who determine the auspiciousness or otherwise of the ceremony. The temple of Kachin which is situated at the outskirt of the capital to which the ruling chief has to pray before he undertakes to perform the ceremony is perhaps dedicated to a tortoise. The totemistic Maharas had perhaps been responsible for this worship but the clever adoption of this deity by the ruling family has solved the problem of incorporation of the Maharas in the Hindu community.

On the 15th day of the dark half of October, in Kumar Amaosa, after the necessary offerings to the souls of the ancestors, the state people living in the capital and neighbouring villages gather at the palace. With the Raja at their head on the back of an elephant, they proceed to the temple of Kachin where arrangements for their reception have already been made. A swing has been previously planted in front of the temple and in the presence of the crowd, a Mahra girl of 7 to 8 years of age who was ceremonially married before to the priest to become eligible for this ceremony, comes out veiled and followed by a group of women of the same caste. The girl with her companions goes round the swing seven times while certain slogans are sung in singsong tune by the women, and after the seventh round, she receives a stick in her right hand and a shield in her left. One man from the crowd, a Teli or oilpresser by caste, comes forward similarly armed and pretends to fight the girl who defends herself against the skilful attacks of the Teli. During this struggle the girl foams in the mouth and swoons and is gently laid on the swing on a bed of the Bel tree where she undergoes a metamorphosis as it were. The gentle swings do not upset her nor does the thorny bed where she lies flat; her eyes are fixed above and the restlessness disappears. The Raja now asks the priest to pray to the goddess to ensure an auspicious Dusserah festival. After the necessary rites have been gone through, the girl shows signs of animation. She pretends to listen to the prayer of the Raja communicated by the priest and slowly takes off a flower garland from her neck, offers it to the Raja through the priest and grants that the Dusserah shall proceed smoothly. The goddess has identified herself with the girl and through her has communicated her blessings on the Raja.

After this function before the temple of Kachin, the Raja returns to the palace with the retinue and holds a Durbar the same evening. The priests in charge of the festival then announce their programme before the goddess which the Raja has to communicate to the Rani and other members of the household. After the programme has been fixed, the Raja ceremonially hands over the duties of the state to his Dewan, who replaces the former as the secular head of the state. This enables the Raja to devote himself wholly to the spiritual duties he has undertaken to perform. The transference of his secular authority to the Dewan by the Raja is immediately followed by a change of attire and the Raja adopts the life of an ascetic for nine days, *i.e.*, as long as the *nawaratri* lasts. He discards his spectacular turban and richly decorated dress, puts on an ordinary *dhoti* and a *pichouri*, wears a wreath of flowers round the head and profusely paints his body with sandal paste. He has to practise many austerities, is not allowed to put on shoes or any kind of footwear, must sleep in cold floors. He is not allowed to use any vehicle. His new rôle is inconsistent with the rights and privileges of kingship and he does not receive nor make obeisance to any person.

Midnight witnesses an important function known as 'Ghat Newata' or invitation to the river, the details of which are similar to those observed in marriage and religious ceremonies all over northern India. Next a 'Mandal' or circle is drawn in front of the Dhanteswari temple and a pot full of water is consecrated in the name of Varuna, the god of water the following day. On the evening of the second day the Raja visits the temple of Maowali (Dhanteswari) and also of Kalanki goddess, both of whom are housed in the same compound, when people sing and dance to the accompaniment of music. After this worship, one of the members of the royal household, secures the services of a Halba usually belonging to the Jogi subcaste of Halbas, whom the Raja selects to play the rôle of an ascetic to be kept in the Durbar hall, for nine days. This man is made to live a life of an ascetic and much hardship falls to his lot during the period of his forced detention. The difficulty of fulfilling the required obligations demanded of the Raja in the rôle of an ascetic due to his accustomed mode of life, and the dread of violating the religious code sanctioned by custom and enforced by public opinion, may have led to the introduction of the Halba ascetic, so that the latter fulfils many of the austerities which the Raja would have to do himself. As the Halbas were the camp followers of the Raja and are reputed to have fought his battles, the selection of a Halba as an ascetic to share the Raja's duties or his austerities can be explained.

The ascetic or Jogi (Halba) is made to sit inside the Durbar hall where a pit, six feet long, three feet broad and one foot deep is dug to accommodate him. An altar is made in the centre of the pit and is strewn with wheat grains on which the Jogi has to sit facing east. In front of him there is a pot of water consecrated to the goddess and behind him is a raised platform made by piling ashes. Near the pot, a stool is placed on which is kept a sword. Over his thighs is placed a wooden plank and nailed to the ground and another plank is placed behind him and pushed straight into the ground, so that the head and trunk of the Jogi may rest against this vertical post. The idea is to keep the Jogi in a sitting posture, for nine days is too long a period for any person to keep a particular posture, unless he is pegged and fastened in the way described. The Jogi has to fast as long as he can, and when he is extremely hungry he is allowed to take some milk or bananas. For all these hardships the Jogi used to receive from the state Muafi villages for maintenance but the system has been replaced by one of payment in cash and kind. When the Jogi is thus secured the members of the royal family and the people at large are at liberty to visit the different temples as, for example, those of Sri Ram Karnakotin, Matadevi (all found in the same compound). The Raja also returns to the palace and performs puja and listens to the recital of sacred hymns.

The third day witnesses the first chariot procession of the Raja and his chariot is pulled by the Murias and Dhruvas who come from far and near to pull the cords. After praying at the temples, the Raja enters the wooden chariot kept in the compound amidst deafening shouts from the crowd and the guard of honour fires the salute. The two ropes are taken by the two tribes, *viz.*, Murias and Dhruvas respectively and the chariot is slowly drawn by them and brought up to the main gate of the palace. The female members of the palace, now come forward and perform the 'Arti' which terminates with another salute of gun fired by the guard of honour. The Raja then alights from the chariot and proceeds to the Dhanteswari temple for worship. The chariots used during the Dusserah are of two sizes, one big and another small and made on alternate years.

Two months prior to the festival the work of construction starts, the small one is made of heavy Sal beams with four wheels made of Sal and a hood supported by six wooden posts. The big one has eight wheels and eight posts to support its hood. The wheels of both are of massive size made from solid Sal without tyres or fixers. Wooden images of men on horse back decorate the front of these chariots which are made usually 25 to 30 feet high. The ropes which are meant to drag the chariots are made of twisted bark very thick and strong and are attached to the front axles. The chariots are tastefully decorated with flags and festoons of variegated designs.

The remaining five days, *i.e.*, till the ninth day, the same programme is repeated and every day the number of women performing the 'Arti' is added by one head till the number increases to nine on the *nawaratri* day. On the eighth and ninth day, the Raja does not go out in his chariot and these two days witness the most elaborate rituals and ceremonies of the festival. On the eighth, midnight worship is done in the temple of Dhanteswari which is performed by the Raja along with the officials of the state. After worship at the Dhanteswari temple the company proceeds to a garden, a quarter mile off from the palace where the worship is continued till dawn. The Raja then comes back to the palace. On the *nawaratri* day there is another interesting ceremony, known as the 'Kumari puja' when nine unmarried girls are worshipped, fed and clothed. The Brahmins are given food and clothes after which the Raja is given a dish of cooked rice which represents the first handful of the newly cropped harvest. The ascetic who was confined in the Durbar hall is now brought out from his pit screened from public gaze and led to the temple of Dhanteswari where he offers his prayers after which he is set free, care being taken that the Raja may not meet him or recognize him in the rôle of an ascetic.

In the evening about 9 to 10 P.M. the news of the approaching palanquin containing the image of goddess Dhanteswari from Dhantewada 57 miles from Jagdalpur, where the shrine of the goddess is situated, is communicated to the Raja. Barefooted with anxious steps the Raja proceeds to the outskirts of the town where he awaits the arrival of the palanquin and with slow and solemn pace he approaches the incoming 'Doli' and respectfully receives it. He puts one pole of the palanquin on his shoulder the other being carried by the hereditary priest of the Dhantewada temple and the 'Divine burden' is carried ceremonially to the Durbar hall of the palace, where the image is worshipped by the Raja. The 'prasad' brought from Dhantewada along with the image is then distributed among the people present. For nine days the Raja has anxiously waited to receive this image, for nine days he has led an austere life, has sacrificed his pleasures and has prepared himself for this great event.

The Brahmins now put their heads together and fix an auspicious hour when the Raja may resume his secular duties. The image of the goddess Dhanteswari or Manikeswari is brought to the Durbar hall from Maowali temple and placed on a throne specially arranged for her and in her presence the Brahmins announce the hour when the Raja should take upon himself the duties of the state. This news is circulated to the public by beat of drums.

At the appointed hour, clad in purple and red, decked with all jewels and ornaments, the Raja returns to the Durbar hall. In the meantime the big chariot waits at the door and the Dandami Marias who have come from the interior to pull the chariot, are at their post holding the ropes of the chariot which they start pulling as soon as the Raja enters it. The huge crowd that has gathered round the chariot are seen flying their banners with various emblems stamped on them, representing the different villages or clans that compose the crowd. The journey on the chariot is doubled this time as the big chariot makes two rounds of the route instead of one done by the small chariot. The Raja after completion of the journey re-enters the Durbar hall where he now receives the members of the household, officials and members of the public who pay *Nazarana* and gifts. The *Durbaries* receive much courtesy from the Raja and are given *pan supari*, attar or scents and garlands. The Raja then returns to his royal apartments.

On the eleventh day of the festival an interesting kidnapping ceremony takes place. While asleep, the Raja is stealthily carried by the Marias in a palanquin to a spot about a couple of miles away from Jagdalpur where he has to encamp in Muria settlements. The Murias and such other tribes that live in the neighbourhood make it an occasion for a hunt in the forests and any game, birds or animals they can secure are offered to the Raja along with rice, vegetables and coins which they can afford. The big chariot is taken to fetch the Raja back to the palace. A swing is placed on the top of the chariot and the Raja is made to sit on it clad in yellow clothes with bow and arrows in hand. The return of the Raja is an occasion for triumphant joy to the people and huge crowds greet the procession while the chariot is dragged home. The Bhatras take a leading rôle in this procession, for armed with bows and arrows they move up and down the route of the procession, shouting their peculiar slogans and parading their self importance before a receptive crowd. As the chariot slowly winds its way back through lively crowds the day fades into twilight and the palace as well as the houses lining the route are illumined by garlands of lights and festoons. The women shower flowers and Chandan on the chariot and welcome their Raja home. Once the chariot is pulled up in front of the temple of Hanuman where a flag is offered in token, it is said, of the help rendered by the latter to Sri Rama in his engagements with Ravana the demon king of Lanka. When the chariot reaches the palace the Raja descends from the swing and hurriedly enters the temple of Dhanteswari where he prostrates himself. Next he goes to the Durbar hall and ascends the throne. The royal mother or one of the principal female members of the royal family comes to receive him back and the former takes some mustard seeds and salt and throws them on all sides of the Raja which assures the safety of the Raja from evil spirits, for the kidnapping of the Raja by the Murias who are reputed votaries of evil spirits makes such precaution necessary.

The thirteenth day is occupied by a thanksgiving worship of the Kachin goddess and large number of goats are sacrificed. The next day there is another function called 'Kutumb Yatra Puja' when under a banian tree about two furlongs away from the palace, all the miscellaneous deities, native and borrowed, are jointly prayed to by the members of the royal household. The last day of the festival celebrates the return of the palanquin containing the image of Dhanteswari to the Dhantewad temple after which the people assembled at the capital for the Dusserah return to their respective destinations. Throughout the ceremony large number of goats and buffaloes are sacrificed which supply rations to the tenants who come to participate in the chariot procession. Some part of the expenses of feeding them is raised by subscription in kind while the state makes financial provision for the purpose.

An analysis of the customary division of labour obtained during the Dusserah festival will show how far the different tribes cooperate among themselves in social, economic and religious life. The construction of the chariot is left with the

Saonras, the Lohars make the iron nails and bars required for the chariot. Dhakars supervise the construction, The Khatis are the special pujaris of the chariots who perform the puja both before and after the construction. The stool on which the sword is kept in front of the Halba Jogi is made by the Sunris. The Gadabas supply bearers for the Raja's palanquin. The Halbas supply the Jogi and also guard the Raja with drawn swords when the latter camps in the Muria settlements. They also take part in the sacrifice as a Halba is invariably engaged to kill animals for sacrifice. The Murias, Dhruvas and Dandami Marias pull the chariot while the Bhatras figure prominently on the occasion of the triumphant entry of the Raja to the capital after the kidnapping by the Murias. The Maharas supply the girl who determines the auspiciousness or otherwise of the festival. The respective importance of the various groups may be gauged by the duties each is required to perform, so that there is a well-assessed division of labour based on the numerical strength and cultural stage of the group concerned. The Bhatras parade armed with bows and arrows which are less effective than swords owned by the Halbas as the latter are supposed to be descendants of old garrisons of the paik militia. The Dhakars who are Rajputs and are the highest cultured group in Bastar are not required to do any manual labour, their duty naturally is supervision only. But whatever be the respective rôles of the various cultural groups, their participation in this festival is indispensable and all the year people wistfully watch for the return of the annual festival. In some sense, however, the existence of the various groups as independent units has become difficult and inter-communication between them and reciprocity in their economic undertakings has become more real than before.

In the organization of temple worship all over the south, the various castes and tribes have been assigned their respective duties, so that economic participation of all the diverse and heterogeneous social groups has become possible. The division of the society based on race has been a recognized principle in the south and the two groups now designated as exterior and interior castes have duties corresponding to their racial affiliations. Thus the exterior castes who belonged primarily to Austroloid or pre-Dravidian substratum of population are allowed to cooperate with the interior castes, which represent perhaps the superior race, the Aryan speaking invaders of the South, in duties which do not bring them together into close contact, while the performance of rites and rituals connected with the worship are done by members of the interior caste. In Bastar, however, the cooperation between the various cultural groups which do not appear to have maintained their ethnic identity is more real and the inferior cultural groups have not been denied important rôles in the organization and performance of the worship.

While in the south the economic partnership between primitive and backward groups has been regarded as essential but no serious attempt has been made to bring together the different groups into a common religious fold, in Bastar the fact of their cultural difference has been forgotten and there is one festival for all in which rites and customs of primitive and advanced cultures have blended together.

SYMBIOSIS AND ACCULTURATION.

In a recent article on 'Social Symbiosis' in *Man*, Dr. Nadel describes, how four different tribal sections originally distinct separate cultural groups which have migrated into their present domicile have reacted and adjusted themselves to each other and eventually evolved a *modus vivendi.* Today there exists between the separate localities and migrant strata the closest cooperation which is the fruit of a far-reaching adjustment. The social, economic and religious activities of these groups are shown to represent a reciprocity and interdependence linking section with section in the framework of a larger embracing social group unit, that is, as Dr. Nadel calls, a symbiosis which represents the possible origin of clanship and is one of the three possible developments in attaining a social equilibrium between diverse cultural groups, cooperation, symbiosis and complete fusion. The example of the Dusserah festival and also other examples of reciprocal relationship and interdependence in economic and social spheres as found in Bastar, which space forbids me to detail here, presents a similar picture and it may be of interest to see if we can borrow the biological concept of symbiosis to explain these group contacts and consequent reactions. Dr. Nadel has justified the introduction of the term 'Social symbiosis' in social anthropology, as it defines, he maintains, a new and specific category of social organization in contradistinction to cultural solutions or fusions wherein the different cultural groups have undergone complete assimilation or have formed one well-developed new cultural group in which the differentiating specific character of the parent cultural groups has been obliterated. The evolution (from many simple and isolated cultural groups) of a complex cultural solution or fusion could be marked into stages as the different cultural groups come in contact, associate temporarily for mutual benefit or as the bonds get closer, associate permanently for mutual benefit (though the groups remain distinct) until finally the distinctive characters of the different constituent cultural groups are lost. But I should think that if Dr. Nadel's idea was to define these stages, he should have brought in 'social commensalism' which would mean different groups living together partaking of the same economic life and mutually beneficial, the association being more or less permanent but does not imply any organic union. At this stage no internal partnership between the different cultural groups could have taken place and dissociation of the commensals would not have been fatal to the cultural life of the groups. A stage may be theoretically conceived when dissociation would mean total discontinuance of cultural existence of the constituent cultural groups. This may be termed social symbiosis. But after all symbiosis is an analogy which will hold good if the continued cultural existence of the symbiotic groups was actually lost by separation, in short, the cultural life of the group suffered death. But from ethnological evidence we find that this is hardly possible in a social constellation, however close the intimate relation between the different cultural groups may be. If we have to borrow any biological concept to interpret such group cooperation and identity of interests, social commensalism would be more appropriate from both the anthropological and biological standpoints. The three stages given by Dr. Nadel would then be cooperation, social commensalism, and fusion. Even then the difficulty offered by simplicity of the term 'cooperation' will have to be met. The idea of symbiosis would be applicable only if the groups of men were so completely dissimilar as to resemble different species of animals and secondly if there could be an organic union or internal partnership between the various cultural groups constituting the symbionts, for symbiosis means an organic union or internal partnership between organisms of different species, so intimate that it can only be severed by death. Even if we replace organism by cultural groups, as Dr. Nadel suggests, and 'death' by discontinuance of continued cultural existence the analogy fails to answer other essentials of symbiosis. But like other concepts introduced in cultural anthropology from Biology and the social sciences which we use loosely or introduce with definite connotation, symbiosis also may be similarly treated and Dr. Nadel's plea for introduction of the concept in Anthropology should be seriously considered.

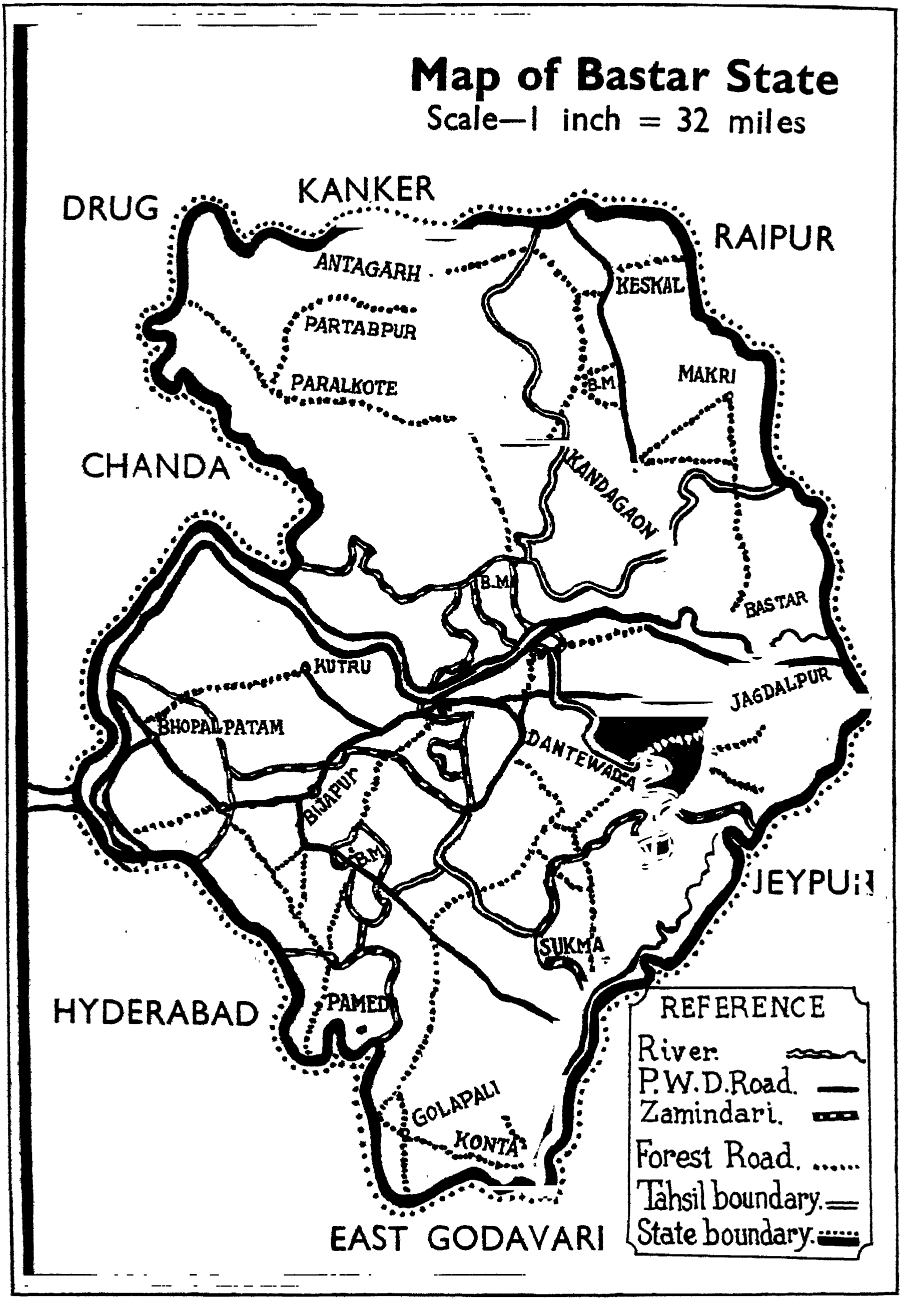
The contacts between social groups have led to miscegenation of cultures. A group which has not lost its interest in life and possesses vitality must adopt traits from other groups. This adoption of alien traits is usually selective and it is on the nature of this selection that the future of the group depends. The process of selective adoption may be called acculturation. When several cultural groups coming from different geographical areas meet and settle down in the same place, they react and adjust themselves to one another and may develop the closest cooperation between them. What Dr. Nadel calls a symbiotic relation is connoted by the process of acculturation and we have seen how reciprocity and mutuality of obligations between the various social groups of a culture area have led to acculturation which has linked section with section and produced an interesting culture complex.

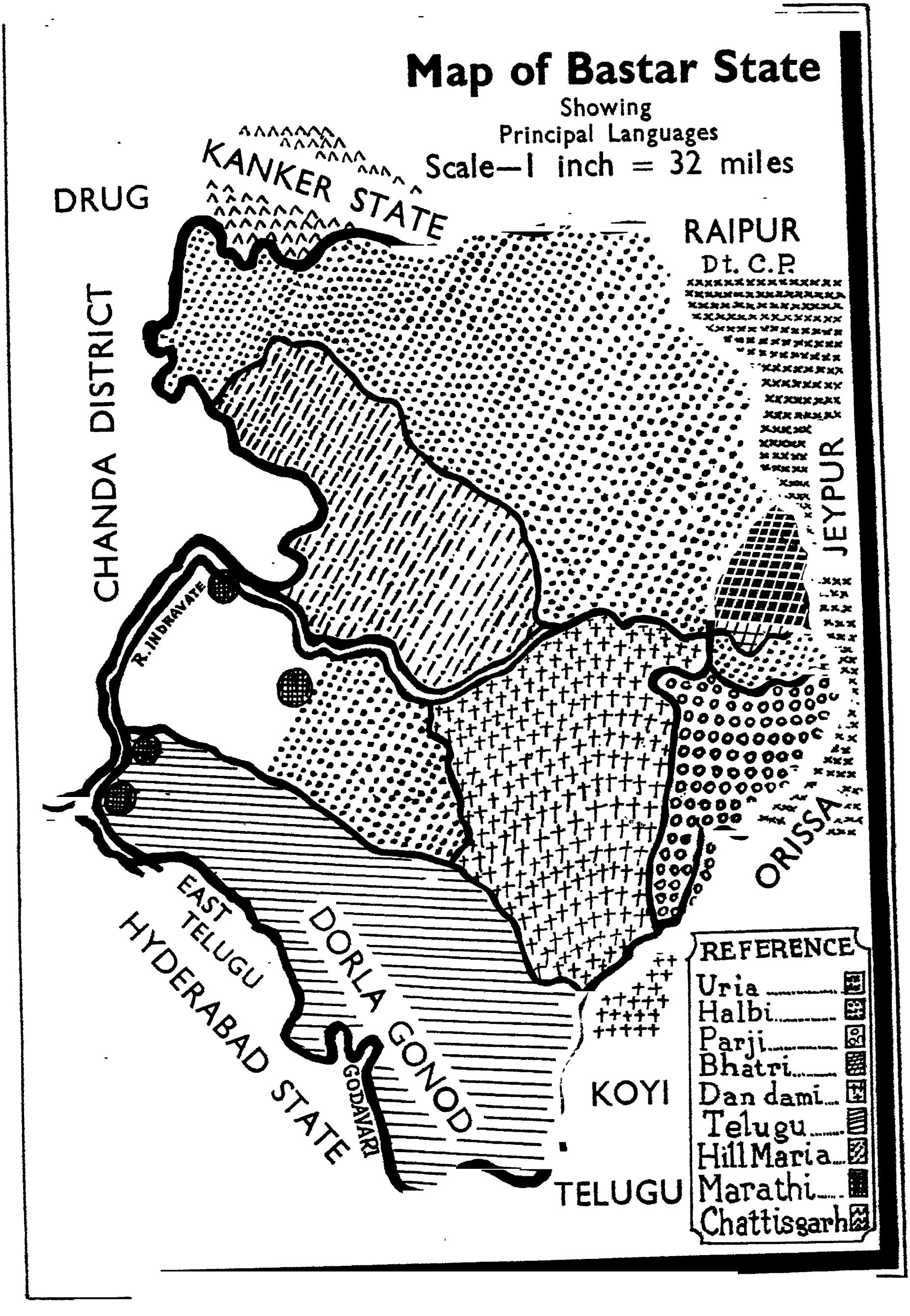
Reduced C.R.L. with their standard errors of the Bastar People.

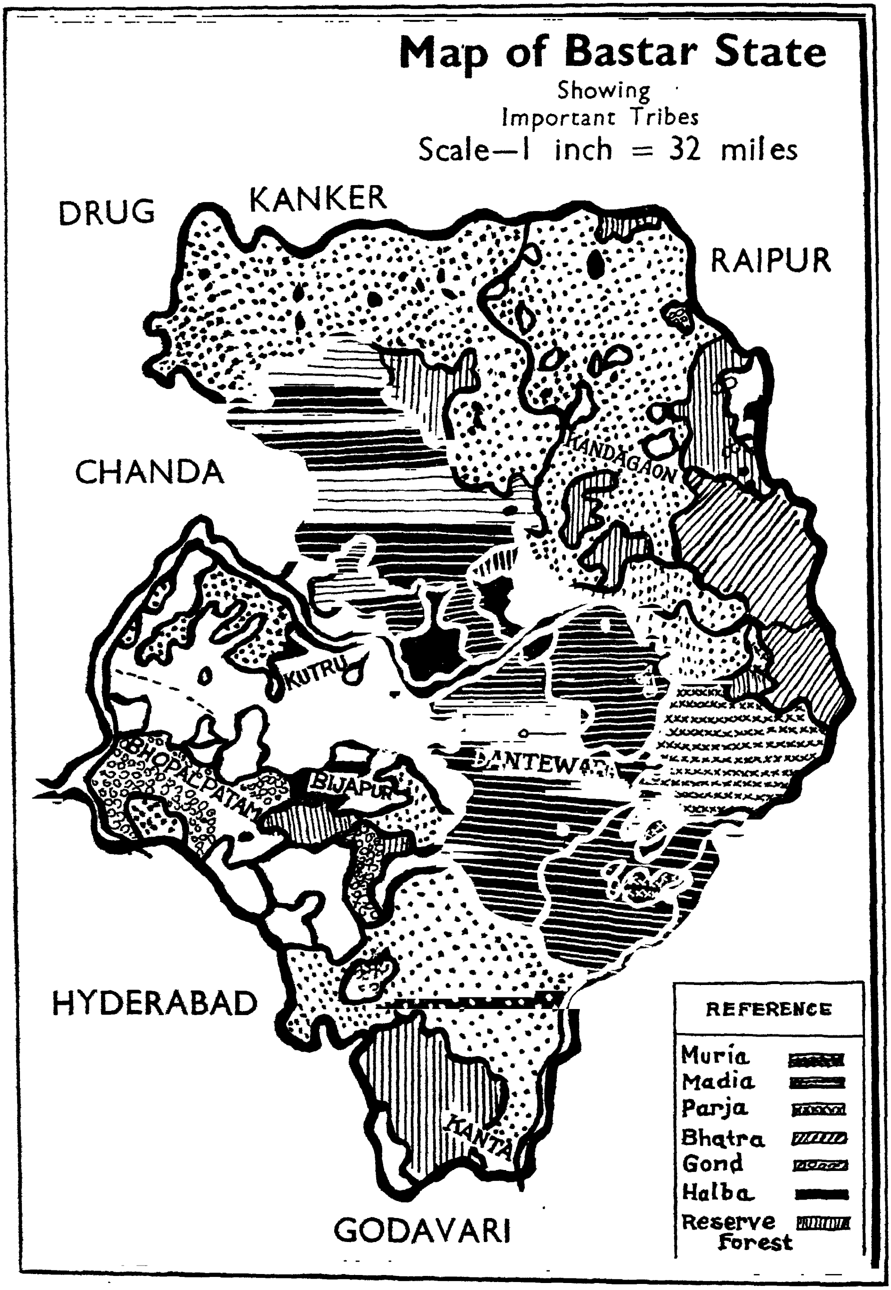
	Dhakars.	Halbas.	Bhatras.	Parjas.	Gadabas.	Nawa-Gonds.	Murias Narayan-pur.	Murias Konda-gaon.	Dandami Marias.	Hill Marias.
Dhakars ..	....	2·16 ±·70	21·20 ±·68	18·16 ±·71	5·41 ±·69	3·85 ±·71	7·44 ±·69	9·50 ±·69	4·96 ±·71	12·28 ±·70
Halbas ..	2·16 ±·70	....	12·90 ±·67	11·82 ±·70	8·41 ±·69	7·35 ±·70	11·57 ±·69	14·71 ±·69	3·16 ±·70	4·46 ±·70
Bhatras ..	21·20 ±·68	12·90 ±·67	....	5·91 ±·68	10·14 ±·67	11·68 ±·68	25·29 ±·67	32·81 ±·67	9·58 ±·68	4·86 ±·67
Parjas ..	18·66 ±·71	11·82 ±·70	5·91 ±·68	....	7·77 ±·69	6·59 ±·71	6·97 ±·69	26·40 ±·69	6·16 ±·71	4·78 ±·70
Gadabas ..	5·41 ±·69	8·41 ±·69	10·14 ±·67	7·77 ±·69	....	0·72 ±·69	4·16 ±·68	5·15 ±·68	1·76 ±·69	5·83 ±·69
Nawagharia Gonds.	3·85 ±·71	7·35 ±·70	11·68 ±·68	6·59 ±·71	0·72 ±·69	....	4·47 ±·69	9·38 ±·69	1·72 ±·71	5·43 ±·70
Murias of Narayanpur.	7·44 ±·69	11·57 ±·69	25·29 ±·67	6·97 ±·69	4·16 ±·68	4·47 ±·69	....	3·75 ±·68	3·70 ±·69	7·94 ±·69
Murias of Konda-gaon.	9·50 ±·69	14·71 ±·69	32·81 ±·67	26·40 ±·69	5·15 ±·68	9·38 ±·69	3·75 ±·68	....	10·05 ±·69	17·99 ±·69
Dandami Marias	4·96 ±·71	3·16 ±·70	4·58 ±·68	6·16 ±·71	1·76 ±·69	1·72 ±·71	3·70 ±·69	10·05 ±·69	....	4·46 ±·70
Hill Marias ..	12·28 ±·70	10·09 ±·69	4·86 ±·67	4·78 ±·70	5·83 ±·69	5·43 ±·70	7·94 ±·69	17·99 ±·69	4·46 ±·70	....
Order of social Procedure.	Dhakars.	Halbas.	Bhatras.	Parjas.	Gadabas.	Nawa-Gonds.	Murias Narayanpur	Murias Kondagaon.	Dandami Marias.	Hill Marias.
	1 (Highest)	2	3	4	5	6	7	8	9	10 (Lowest)

Crude Coefficient of Racial likeness of the Bastar People.
Standard Error for all 0·35.

	Dhakars.	Halbas.	Bhatras.	Parjas.	Gadabas.	Nawagharia Gonds.	Murias Narayanpur.	Murias Kondagaon.	Dandami Marias.	Hill Marias.
Dhakars ..	....	1·09	11·01	9·08	2·76	1·93	2·79	4·84	2·48	6·20
Halbas ..	1·09	....	6·77	5·97	4·31	3·71	5·96	7·58	1·60	5·14
Bhatras ..	11·01	6·77	....	3·07	5·38	6·07	13·40	17·39	4·98	2·56
Parjas ..	9·08	5·97	3·07	....	3·96	3·29	2·55	13·46	3·08	2·41
Gadabas ..	2·76	4·31	5·38	3·96	....	0·37	2·16	2·68	0·90	2·99
Nawagharia Gonds. ..	1·93	3·71	6·07	3·29	0·37	....	2·28	4·77	0·86	2·74
Murias of Narayanpur ..	2·79	5·96	13·40	2·55	2·16	2·28	....	1·95	1 89	4·09
Murias of Kondagaon ..	4·84	7·58	17·39	13·46	2·68	4·77	1·95	....	5·12	9·27
Dandami Marias.	2·48	1·60	4·98	3·08	0·90	0·86	1·89	5·12	....	2·25
Hill Marias ..	6·20	5·14	2·56	2·41	2·99	2·74	4·09	9·27	2·25	....


Map of Bastar State
Scale—1 inch = 32 miles
DRUG
KANKER
RAIPUR
ANTAGARH
KESKAL
PARTABPUR
PARALKOTE
B.M
MAKRI
CHANDA
KANDAGAON
B.M
BASTAR
KUTRU
JAGDALPUR
BHOPALPATAM
DANTEWARA
BIJAPUR
B.M
JEYPUR
SUKMA
HYDERABAD
PAMED
REFERENCE
River
P.W.D.Road.
Zamindari.
Forest Road.
Tahsil boundary.
State boundary.
GOLAPALI
KONTA
EAST GODAVARI


Map of Bastar State
Showing
Principal Languages
Scale—1 inch = 32 miles
DRUG
KANKER STATE
RAIPUR
Dt. C.P.
CHANDA DISTRICT
JEYPUR
R. INDRAVATE
ORISSA
EAST TELUGU
HYDERABAD STATE
DORLA GONOD
GODAVARI
KOYI
TELUGU
REFERENCE
Uria
Halbi
Parji
Bhatri
Dan dami
Telugu
Hill Maria
Marathi
Chattisgarh


Map of Bastar State
Showing
Important Tribes
Scale—1 inch = 32 miles
DRUG
KANKER
RAIPUR
CHANDA
KANDAGAON
KUTRU
BHOPALPATAM
BIJAPUR
DANTEWA
HYDERABAD
KANTA
GODAVARI
REFERENCE
Muria
Madia
Parja
Bhatra
Gond
Halba
Reserve Forest

SECTION OF MEDICAL AND VETERINARY RESEARCH

President:—RAO BAHADUR T. S. TIRUMURTI, B.A., M.B. & C.M., D.T.M. & H., F.N.I.

Presidential Address

A BRIEF ACCOUNT OF THE HISTORY OF PATHOLOGY

The Importance of the study of the History of Medicine.

> "We cannot know Modern Medicine, unless we study it as a whole, in the past as well as in the present."
>
> (Clifford Allbutt.)

No apology is required for my choosing for the Presidential Address this year the above subject—'A brief account of the History of Pathology', when we all know that, in none of the Medical Colleges or Schools in our country, a Chair for 'the History of Medicine' has been created or the subject of 'the History of Medicine' included in the curriculum of studies of the Medical student or admitted for post-graduate study or research.

The branches of Medicine have become more and more divided and sub-divided and each, in turn, so much highly specialized that the student of medicine requires a watch tower, from which he could survey Medicine as a whole from its dim, indeterminable origins in the past to its bright glorious scientific achievements of the present-day. Only a study of 'the History of Medicine' can be the golden key, which will open to the student the door of the great 'Edifice of Medicine', wherein he can obtain an insight into the highest human endeavour to fight and subdue or prevent disease. 'The History of Medicine' is a fascinating story of the most laborious and painstaking of all human enterprises.

Fortunately, a study of the 'History of Medicine' is no longer merely a diversion for the ordinary historian, the philologist or the student of the classics, as it was until the close of the last century. In 1902 was founded the first German Society for the study of the 'History of Medicine'. In 1905, the Institute for Medical History was established at Leipzig. Materials for study were collected from libraries, old manuscripts, ancient classics, biographical sketches, bibliographical references, etc. More and more materials were gathered. The Medical Profession, since then, have begun to realize the cultural value of the scientific study and interpretation of the 'Evolution of Modern Medicine' from the earliest times. Apart from its general cultural value to all persons, to the practising clinician a historic perspective of the subject is useful towards his attempts to solve many problems of disease and its processes.

The world-famous Professors of Medicine and Surgery have been also great students of 'the History of Medicine', and in their writings and teachings have systematically adopted the 'Historic Approach' to the elucidation of the subject. The last three decades of our century have produced a number of distinguished Medical Historians, but not one of them belongs to India.

The essence of the scientific method should guide the medical historiographer. The 'History of Medicine' is not a mere collection of dates and names. It attempts to describe in a scientific manner from the earliest recorded times to the present day, how man reacted to his environments and their unfavourable conditions, how he got over them and in what way his wounds were healed and sufferings relieved and diseases cured or prevented. A mere listing of the herbs or drugs, used in healing the sick, or of instruments, employed in Surgery, is of no great value. It will be a catalogue, not history.

The philosophy, underlying medical thought in the successive epochs of man's history, should be properly understood and explained. That the antiquity of disease is co-eval with the antiquity of man has been shown by the examination of human bones, unearthed from the bowels of the earth in archæological explorations and geological excavations, and in the bodies of Egyptian mummies, preserved from remote times. A special subject like Paleo-Pathology has been ushured by the careful study of the above materials.

Separate chairs for 'the History of Medicine' have been instituted in all progressive countries, in the Universities and Colleges. In many Universities it is a compulsory subject for a Doctorate in Medicine. In other places there are Institutes for the study of 'the History of Medicine'. The International Society for the study of 'the History of Medicine' has its headquarters in Paris. The Charaka Club flourishes in America and not where Charaka was born. In America and in the Continent, there are many Societies for the study of 'The History of Medicine'. Medical History Libraries and Medical Historical Museums have come into existence in other countries. Their educative value is immense. The best known Medical Historical Museum is the Burroughs Wellcome Medical Historical Museum in London.

In India there has been an utter neglect of the study of this important subject. Materials for such study are vast and varied. 'The History of Indian Medicine', including the Indigenous Systems of Medicine, is yet to be written. The Royal Asiatic

Society of Bengal has not devoted sufficient attention to Medical Historiography. Only three fasciculi of Susruta were published by it, but many of the old books on Medicine in this country, written in Sanskrit and other languages, are still sealed books to us. Only the Calcutta University published in 1921 the Tanjore Manuscript of 'Bhela Samhita'. The other Indian Universities have not endowed or encouraged medical historical research. The responsibility for research rests with both the Profession and the Universities. Rare texts await print; hidden books have to be searched out; old manuscripts require to be copied; palm leaf bundles of ancient writings need attention from crumbling into powder and from attack by white ants and moulds. The theories and descriptions of diseases in the Vedas, folk medicine in the Jatakas, ancient Classics, Medicine of Aboriginal Tribes, Nature and Naga Worship, Yoga Shastras, Tantras, Puranas, Kavyas, legends, writings of other ancient historians about India, etc., will afford fruitful material for study.

The special study of, or research into 'the History of Medicine' is not undertaken, because there is no employment open for such specialists in the Colleges; and it is foolishly thought that such study is derogatory to the reputation of the doctor or is an impediment to the progressive Science of Medicine. Nothing can be farther from the truth.

I fervently hope that, at least in the future, the Medical Student will be trained to look at his subject from a 'Historic Perspective' and that the Universities and the Medical Profession will bestow some attention to the encouragement of this branch of Medical Science, because, in my opinion, 'the History of Medicine' is largely 'the History of Pathology', the story of man's conception of 'the Nature of Disease and Disease Processes' and his great endeavours for the cure of disease, alleviation of suffering and prevention of disease.

'Nothing gives a better prospective of the subject than an appreciation of the steps, by which it has reached its present state.'

A knowledge of 'the History of Medicine' is necessary also for the Medical teacher, who wishes to distinguish himself as a really capable teacher or desires to stimulate in his students an interest for research. He should supplement the detailed presentation of his subject, 'by its historic milestones and landmarks, its triumphs and failures, its pathways and pitfalls'.

'History maketh a young man to be old without either wrinkles or grey hairs, privileging him with the experience of age, without either the infirmities or the inconveniences thereof. Yea, it not only maketh things past present, but enableth one to make a rational conjecture of things to come.' (Fuller.)

The Test of Civilization.—The test of Civilization is the degree of advancement of the Medical Science of the people. The benefits conferred by the Physical Sciences—the train, the telephone, the telegraph, the auto-mobile, the radio, the air-plane, etc., are appreciated by the people, as these benefits are positive contributions to their convenience, comfort or pleasure. But the contributions of Medical Science are not remembered by the general public, as the benefits, which have accrued from it, are negative in their quality. The 20th century man does not appreciate them fully. His appreciation is occasionally expressed in his ardent desire to guard himself from epidemic or communicable diseases. But there are still those who offer active opposition to the progress of modern medicine. Cult healers, faith-curers, anti-vivisectionists, etc., will decry scientific medicine. Owing to the vast amount of illiteracy and the poverty of the people in this country, primitive ideas continue to be deep-rooted in the minds of the people. Even knowing persons have no objection to enjoy all the material comforts, which Physical Sciences have provided in modern civilization, but they will still cling to ancient methods and philosophies of medicine, unable to adapt themselves to changing ideas and altered methods of the modern Science and Art of Medicine.

The Philosophy of Medicine.—The conception of the Etiology, Pathology and Patho-genesis of Disease may be called 'the Philosophy of Medicine'. There are two philosophies in medicine: One is the Primitive Philosophy, which is based on superstition, and the other is the Modern Philosophy, built on the bed-rock of Reason and Experiment. According to the Primitive Philosophy of Medicine, Disease is caused by Supernatural Agencies, whereas the Rational Philosophy of Medicine teaches that Disease arises from Natural Causes and that it is only by a knowledge of such causes that disease can be prevented. Primitive peoples continue to believe in their primitive medicine. To them disease is a mystery. But the civilized peoples seek to unravel by patient research this tangled skein of the thread of mystery. Even modern man's instincts and impusles, and beliefs and mental re-actions, are seen on analysis to be the same as those of the primitive man, many thousand years ago. Hunger and love were the two great powers to our ancestors, as they are to us even to-day. Though still a savage in instinct and impulses, the man of the 20th century is modern in his dress and diet, housing and furnishing, manners and speech. Though under the treatment of the best physician of the Modern Science of Medicine, he cannot abandon his intuitive ingrained belief in the physician, practising the Primitive Medicine of his forefathers. Few educated people have been educated to think or reason logically in matters of health, especially, when they are themselves ill. Faith and Sentiment are more over-powering than cold Reason. We are loathe to give up the philosophies of our ancestors, and therefore willingly seek the aid of the practitioners of Primitive Medicine, consult Astrologers, offer Prayers and Oblations or pay for the removal of the influence of the Evil Eye or for driving the Evil Spirit. How often our outer veneer of conventions hides a primitive savage mind and heart within! Only when Civilization advances, does Rational Medicine replace Primitive Medicine.

Origin of the Healing Art.—Ever since the existence of man, diseases have afflicted him and he has attempted to combat them. The primitive man sought medical aid only for external injuries, wounds inflicted mostly by the weapons and the blows of his enemies and the bites of wild animals, burns and bruises, fractures and contusions. It is from the instinct of self-preservation that the noble art of healing has sprung. Primitive man knew how to dress a wound, check bleeding or put up a fractured limb in splints. Archæological research has revealed that he was fairly conversant with surgical instruments of various sorts. But about internal diseases he knew very little in the pre-historic days. We have to draw only on our imagination about the mind and philosophy of the pre-historic man.

Primitive Medicine and Supernatural Concept of Disease.—Disease has existed from pre-historic times and many geological ages. History tells us that queer and elaborate ideas, regarding the nature of disease, were entertained by man from very early times. Disease was a mystery and supernatural agencies were called to account for the origin of disease. The religious belief, in such supernatural agencies as Malicious Gods or Malevalent Demons or evil enemies, made these primitive people to resort to their Priests or Witch Doctors, to the use of Charms or Tòtems, or to the performance of Ceremonies or Sacrifices, with the object of appeasing the wrath of these supernatural agencies.

As the primitive man could offer no rational explanation to the cause of disease, he conceived that supernatural agencies, such as, Evil Spirits, Gods or Demons, evil minded Witches, or Adepts of the Dark or Occult Arts, brought about disease. The treatment was, therefore, directed against these agencies.

Such belief in supernatural agencies may be seen even now in the belief of a large number of our people in Astrology and in Omens. It is considered possible to cause disease by casting the Evil Eye. Belief in Miracles, in Christian Science and in olden days in the 'King's Touch' and in the blessings of the elderly and religious people—all these are evidences of the undoubted psychological influence of the mind over the diseased body. Even to this day, such beliefs are held by the aboriginal tribes and the illiterate and uneducated peoples. Even in many of the civilized and educated men of the 20th century, such beliefs can be exposed by psycho-analysis.

Therefore, treatment of diseases gradually became the specialized occupation with religious cults, and, in course of time, specially qualified persons to practise the Art of Medicine arose among them. Such were the early professional Mendicants, Quacks and Charlatans, who offered to cure disease by Magic, Charms, Amulets and Incantations. To the same category belonged the 'Medicine Men' of the Red Indians, the 'Wise Women' of the ancient Germans and the 'Priest-doctors' of Babylon, Egypt and other countries.

Luther himself believed that some internal diseases were caused by Demons. Every disease was ascribed to some demoniacal power or evil spirit. The anger of the offended Deity had to be appeased or counteracted. Supernatural causes of disease were believed to be capable of being attacked only by supernatural means and occult practices. From the Folk Medicine of primitive times, the history of medicine has to be traced. From Folk Medicine, Modern Medicine has developed.

During Homeric times, Medicine does not appear to have been dominated by Religion. Asclepius (or Aesculapius) plays the role of a King and not a God. But later Asclepius was defied and a temple was built to the 'God of Healing'. Subsequently, the temple structure and the image remained, but the Spirit of the Science of Healing, Enquiry and Research, had departed.

In the very early times, therefore, apart from the supernatural concept of disease and the collection of clinical descriptions of various diseased conditions, no systematic attempts appear to have been made for the study of Pathology, as we now understand it. Leaving the primitive superstitious and fanciful theories of disease, we next come to the 'humoral conception of disease' in the golden age of Greece. The Humoral Theory appears to have been prevalent in the old Greek Empire, the Roman Empire and even during the medieval period. It persisted practically till the establishment of the 'Cellular Theory' of the nineteenth century. The Humoral Theory, though of great antiquity, should be regarded as the most important of the early pathological concepts of disease.

The Sources of the Medical Art.—During historical beginnings, primitive man was accumulating facts, derived from observation and experience. In his search for food, he selected edible plants and animals and discarded the rest. He gained experience of poisonous plants and of those, which had carminative, purgative, expectorant, diuretic or other therapeutic properties. He experimented with them and made also many accidental discoveries. The drugs were put to test by repeated administration in selected patients. The sources of the Medical Art, were, therefore, accidental discoveries and repeated experiences. Also observations of 'Nature', such as, the behaviour of diseased domesticated animals, were carefully recorded. But, in spite of correct interpretation of observed facts, he was superstitious and believed in Magic and Miracles.

In early medieval times, the medical art had made considerable progress, but during the dark ages it sank into superstitious speculations. Reason and Enquiry were abandoned.

When Monasteries sprang up, they became the custodians of culture. With the Renaisance of Arts came the Revival of Medical Science. The destiny of the Medical Science was determined by the standards of civilization and its progress or decay coincided with the advance or regress of civilization.

Surgery occupied an humble position, similar to the handicrafts and the practice of surgery was regarded as an humble occupation. The name 'Surgery', mutilated from '*Chirurgia*', is derived from the two Greek words—cheir, hand; and ergein, to work. With the establishment of Universities, where Natural Sciences and Medicine were taught along with the Humanistic Sciences, Scientific Medicine branched off from Folk Medicine and even opposed the latter, exposing all its superstitions and unfounded beliefs. Surgery developed along with Internal Medicine, until the two merged together to form the modern Scientific Medicine. Scientific Medicine is barely 400 years old and today Surgery claims first rank.

ANCIENT HINDU MEDICAL SCIENCES.

Chemistry.—It developed from two sources—Industry and Medicine. As early as the Gupta times India had attained high industrial development. India was famous for the tempering of steel and King Porus is said to have asked for 30 lbs. of steel in preference to gold or silver, for being taken as a present to Alexander, the Great. The chemical industries of dyeing, tanning, soap-making, etc., had then reached a high degree of perfection. Even in the 6th century the Hindus had known the various chemical processes of distillation, sublimation, calcination, etc. From India the Science of Chemistry spread to the Persians and from them to the Arabs, who later were instrumental in spreading that knowledge into Europe.

Anatomy and Physiology.—Even as early as the 6th century B.C., Hindu Physicians had made great advance in these sciences. The processes of digestion were well-understood. Atreya anticipated Weismann by 2,400 years. Atreya (500 B.C.) held that the parental seed is independent of the parental body and contains in itself, in miniature, the whole parental organism. The development of the fœtus was described with much accuracy. It was noted that the sex of the fœtus remained undetermined for sometime. It was also held that the sex of the embryo could be influenced by food and drugs.

Ayurveda.—The earliest records of Hindu Medicine are in the *Atharva Veda.* In this work a list of diseases is found with description of symptoms and magical formulæ. Medicine arose as an adjunct to Magic. That Medicine and Magic have had a common ancestry is the popular belief but it is not true. The history of medicine reveals that medicine, though it may have had its early origins in magic, was always the enemy of magic. The oldest system of Hindu Medicine is the *Ayurveda* (the science of longevity), which is a part of the *Atharva Veda*. The *Rig Veda* mentions over a thousand herbs, used for the treatment of diseases. Even in the Vedic times, Physicians and Surgeons were differentiated from the Magic Doctors. Great physicians are said to have lived in houses, surrounded by gardens or herbaria, in which they cultivated medicinal plants.

High Standard of Hindu Medicine in Ancient Times.—The great teachers of Hindu Medicine were Susruta, who lived in the 5th century B.C., and Charaka in the 2nd century A.D. Susruta was the professor of medicine in the then existing famous Benares University. He is stated, according to mythology, to have learnt from Dhanvantri, the Physician of the Gods. His works were in sanskrit. Charaka composed an Encyclopædia of Medicine, known as '*Charaka Samhita*', which is still extant. Later, came Vagbhata (625 A.D.) and Bhavamisra (1550 A.D.). The latter produced a voluminous work on anatomy, physiology and medicine. He is said to have described the circulation of the blood a hundred years before Harvey.

That the medical and surgical arts had reached a higher standard earlier in India than in other countries will be evident from a perusal of the ancient works of Susruta and Charaka. Despite brahminical prohibitions, Susruta advocated the dissection of dead bodies as indispensable for the training of a surgeon. Vaccination, unknown to Europe before the 18th century, was known in India as early as 550 A.D. The Science of Hypnotism and Hypnotic Therapy appear to have orginated among the Hindus. This knowledge spread to Egypt and later to Greece.

Pathology in Charaka and Susruta.—In both Charaka and Susruta Samhita a separate division, consisting of several chapters, has been reserved for the subject of pathology. The Section on Pathology is known as '*Nidana Sthanam*'. Charaka deals with this subject in eight chapters. In the *Susruta Samhita*, which consists of six divisions, the second one, consisting of 16 chapters, is devoted to the pathology of surgical diseases. The ages of Charaka and Susruta have been variously estimated. It has been stated that they lived during the 2nd and 5th century A.D. respectively. Other historians have fixed the time of Susruta as 500 B.C. In the modern researches in the antiquity and theory of *Ayurveda*, a new interest in the Indigenous Systems of Medicine has been aroused, not only among Indians but among Western Scholars. It has been stated by some medical historians that, owing to the essential affinity, between *Ayurveda* and the old Greek Medicine of Hippocrates, and owing to the deep gulf in historical knowledge between the age of Hippocrates and the age that witnessed the evolution of *Ayurveda*, it is difficult to fix how much *Ayurveda* borrowed its essential features from the Greek medicine.

Indebtedness of Greece to India.—It is, however, generally held that the Hindu Ayurveda was of earlier antiquity and influenced the Greek concept of disease. Hippocrates is stated to have lived between 460–370 B.C. and to have propounded the Humoral Theory, but *Ayurveda*, as the name suggests, may be as old as the Vedas themselves, and the Vedas have been admitted by European scholars to be the oldest books in the world. It is stated that there are significant passages, which unmistakably point to a well-established system of medical treatment to have been in vague at the Vedic period. Opinion is, therefore, overwhelmingly in favour of the theory that the Medicine of the Greeks was largely borrowed from India. It can be definitely stated that the fundamentals of *Ayurveda*, especially, the concept of the '*Tridosha*' was not borrowed from the Greeks or from any other nation. Many facts have been adduced by Scholars that ancient Greece, directly or indirectly, owed her Medicine and especially the famous 'Humoral Pathology' to the ancient Hindus. Historical researches have shown that the ancient Hindus were a great maritime, highly enterprising and colonial race. Indians had colonized in Greece. The colonists carried the seeds of the Hindu Culture, including Hindu Medicine, and sowed them on the virile Greek soil.

It has been stated on high authority that modern Europe owes its system of Medicine directly to the Arabs and through them indirectly to India. It is probable that Medical Science developed for some time by contemporary contact and mutual influence in India, Egypt and Babylon. A general survey of Indian Medicine from the Vedic and Buddhist periods, followed by centuries of slow progress, and later of stagnation, will give the medical student the true historic perspective, which is essential for the culture of a successful physician. It is with a view to stress the importance of the study of 'the History of Indian Medicine' that I have somewhat degressed from the main subject of my address.

Sources of Ayurveda—Science, Philosophy and Religion of the Hindus.—The sources of *Ayurveda* are scattered among such works of Philosophy as *Nyaya* and *Samkhya Darsanas*, and such works of religion, as *Vedas*, *Puranas* and *Ithihasas*. To the majority of us, of the present day, such a mix-up of Science with Philosophy and Religion must seem unscientific. But, it should be remembered that in *Ayurveda*, as in Hindu thought generally, all branches of study, Science, Philosophy and Religion are ever associated with one another. If the scope of science is to ascertain the truth in every possible branch of knowledge, no sphere of enquiry is beyond the legitimate field of science. The ancient Hindu thinkers have evidently been of the same opinion as the scientist, Karl Pearson, that to draw a distinction between science and philosophy is obscurantism. To the ancient Hindu, all branches of knowledge formed one connected whole. The association of Philosophy, Religion and Science is on axiomatic proposition in Hindu thought. To him, philosophy was not a pure speculative theoretical study, dissociated from the problems of life. It was considered to be of practical value in regulating his daily life.

'The Theory of *Tridhathus* and *Tridoshas*' forms the foundation of Ayurvedic Physiology and Pathology. It is unfortunate that this theory should be confused with 'the Hippocratic Humoral Theory'.

I am informed by authoritative opinion that the three *Dhatus—Vata*, *Pitta*, *Kapha* are, most emphatically, not the three 'Humors'—wind, bile and phlegm. The Hippocratic humoral theory consisted of four humors. It had nothing to do with the *Tridhatu* conception of Ayurvedic Medicine. According to the Ayurvedic conception, health and ill health are the functions of '*Dhatu* Equilibrium'. When normally disposed, the '*Dhatus*' are in their pure state, fit to be built up into the body; when abnormally disposed, they are in their '*Mala*' or impure state, only fit to be rejected and thrown out of the body. When the '*Dhatus*' become impure, they are known as the '*Doshas*'. Therefore, the '*Dhatus*' and '*Doshas*' are only two different states, which stand in the relation of cause and effect.

I am not competent to pass any opinion on this Ayurvedic Concept of Physiology and Pathology. It is enough for me to draw your attention to the fact that we have gone beyond Virchow's Cellular Pathology. The original simple conception of the cell has given place to the view that there are enormous complexities in the cell, as evidenced by the growing sciences of Immunology, Endocrinology and Psychology. Western scientists have begun to talk of emotional and mental states. When will our daily increasing knowledge of Immunology, Bio-Chemistry, Endocrinology, Psychology, Vitaminology, etc., lead us to a radically changed newer concept of disease, it is not possible for me to prognosticate. The tendency appears to be towards a more rational concept of a Humoral Theory, modified, though it may be, from the oldest and most famous Ayurvedic Concept.

HINDU CONCEPTION OF THE UNITY OF LIFE—RELIGION, MORALS AND SCIENCE.

The stable quality of the Hindu culture lies in the fundamental belief in the Unity of Life, the Wholeness of Life. To the Hindu, all the Three Elements of Civilization—Religion, Morals and Science, form an indivisible whole. To him, religion alone is not truth, nor science alone. He conceives that religion and science should balance each other for the maintenance of good morals. It has been said that the most stable period in Indian History was the Hindu Period, when religion, morals and science balanced one another, and produced a harmonious whole. But now, science has ascendancy over religion among men but to the Hindus to lack religion is as bad as to lack science. Osler has said that 'the quest for Righteousness is Oriental, the quest for Knowledge, Occidental'.

Hindu Concept of the Body, Mind and Soul.—In those golden days of the high water mark of *Ayurveda*, Religion and Medicine always went together. They were inseparable companions. When medicine failed to comfort and solace the sick, the physician resorted to prayer and what specifics failed to do, incantations often achieved.

Religion, Faith and Hope are the most powerful curative agents in disease to-day, as in the days of yore. Patients will continue to seek such aids for a cure. The infusion of Faith and Hope has a powerful stimulant action on the mental factor of patients, and the Mind plays a very important part in the Healing Processes. According to the Hindu and the Zoroastrian religions, prayer is the best of all medicines, and it has always been and will ever continue to be the greatest source of solace and comfort to the sick.

In Hindu-thought there has never been any isolation of the several branches of study. According to the Hindu Physiologists, man is divisible into his physical body, plus his mental body, plus his *Atma* (and not merely the physical body, according to the Western conception). The Hindus conceived that both mind and body are equally 'matter'. Prof. Sherrington has stated that the physical and mental processes are very much alike. To him, the mind is as material as the body. The view of Prof. Sherrington was the accepted view of all schools of Hindu thought. They have always held that both Mind and Body are alike 'Matter', though the 'matter' of the Mind is subtler than that of the Body, which is comparatively gross.

Therefore, according to the Ayurvedic conception, the functions of *Vata*, *Pitta*, *Kapha* included both physical and mental processes. It is, therefore, contended that the Ayurvedic conception of the functions of the *Tri-Dhatus*—*Vata*, *Pitta*, and *Kapha*—cannot be expressed in terms of Western physiology at the present day. There is no use trying to fit in Ayurvedic conceptions with Western conceptions of medicine, where they refuse to harmonize with each other. According to the advocates of *Ayurveda*, the basic ideas of Ayurvedic Medicine should not be distorted to fit in with those of Western Medicine. The '*Tri-Dhatu* Theory' is not the 'Humoral Theory of Hippocrates' or its various subsequent modifications.

The 'Cellular Theory' of Virchow has tolled the knell of the Greek 'Humoral Theory', but the *Tri-Dhatus* physiology of *Ayurveda* is stated to go beyond the 'Cellular Theory'. At present, the '*Tri-Dhatu* Theory' of Ayurvedic physiology cannot be compared with the existing ideas of Western physiology.

There is, however, this fact, which has to be recognized; that, whereas the concepts and theories of disease have undergone a large number of variations and alterations in the West, the 'Theory of the *Tri-Doshas*' of Ayurveda has continued to remain the same, ever since the time it was propounded in the prehistoric Vedic period.

To those who question why India did not contribute to any great advance in medical science until recently, I recommend a closer study of Indian History, including the social and religious institutions.

A brief summary of the recent contributions of India to the science of pathology, human and veterinary, will be given towards the close of my address.

Babylonian Medicine.—Babylon in Mesopotamia was the cradle of culture in 300 B.C. We have evidences that the art of healing was far advanced even then. Surgery was subordinate to internal medicine. The proper medical profession was represented by physicians, who were educated in the medical schools. But, the surgeon had to learn his art by a period of apprenticeship under a master-surgeon. Babylonia was a country devoted to Astronomy and Astrology. Along with mystical conceptions of pathological causes of disease, demoniacal and cosmic influences were considered to be causal agents. That diseases were caused by parasites, gaining entrance into the body from without or originating internally, was known even in those early times. It was thought that actual worms brought about inflammations, suppurations and tumours. But fevers and chronic diseases were supposed to be caused by a derangement of the body fluids, particularly of the blood and lymph. On this the humoral pathology was based. We know that the old Babylonian physicians used a great many medicines, belonging to the three natural kingdoms and have used a great many surgical implements. It is very interesting to read the spirit of that age, which considered that the surgeon should be paid high fees for a successful operation, but should be severely punished for failure.

Egyptian Medicine.—The cultures of both ancient Babylon and Egypt appear to be closely allied in many respects. For the history of medicine Egypt is very important, because it was in Egypt that the 'Papyros Ebers', which is considered the greatest book on the medicine of the age was discovered by the famous German-Egyptologist, Ebers. In addition to priest-doctors, famous medical schools existed. The practice of embalming mummies, which prevailed in ancient Egypt, enabled Egyptian doctors to make a superficial study of Anatomy. As dissections were forbidden by the priests, a more accurate knowledge of the human body was not possible. As in Babylonia, so is in Egypt. Diseases were attributed to the derangement of the body fluids, though in the diagnosis of diseases, the Egyptians were more advanced. The clinical methods of Inspection, Palpation and Auscultation by the ear were known to them. Also the Egyptian medicine was built up on the same Humoral Pathology. There, as elsewhere, the mixing up of medicine with religion acted as a great hindrance to real progress. The old Egyptians appear to have had advanced views on hygiene and sanitation. The Prophet Moses had drawn up the Sanitary Code for the Hebrews, but Moses wisely incorporated this code into their religion. As among the Hindus, so among the Jews, personal hygiene was made part of the religious observances.

Greek Medicine.—The Greeks were a highly talented and free-thinking people. They preferred unprejudiced observation of 'Nature' to mere reasoning or unreasoning speculation.

The Temples of Aesculapius were places of worship and pilgrimage to the Greeks during the Pre-Hippocratic ages. The Greeks presented to the God of Healing in these temples their offerings, when they were cured, in the form of oblations, made of stone or terra-cotta, in the shape of some parts of the human body (hands, feet, head or internal organs). Before the time of Hippocrates, the temples were places, where treatment was given by suggestion, often inducing sleep. This is known as the 'Temple Sleep' of the ancient Greeks. With or without the aid of narcotics, the patient was induced by suggestion into sleep. The hypnotic sleep and suggestion were effective as therapeutic agents in certain ailments, especially, neuroses. It was only during the time of Hippocrates that these temples became the real resorts of the sick—hospitals or sanatoria.

The members of one family in particular claimed direct descent from Aesculapius, the God of Healing, and the family was known as the Asclepiadae. The monopoly of healing was preserved in the family and the art was handed down from father to son. To this family of Asclepiadae belonged the famous Hippocrates, the father of medicine, whose statue we still possess and whose 'oath' has been handed down to this day.

It is very interesting to note that he kept the most exact records of his observations engraved on wax tablets, which were then in use long before the invention of paper. From his writings we learn that he was a very keen observer and that nothing escaped his attention. Nothing appeared to him too small or insignificant. On perusing his writings we wonder whether they could have been written 2,500 years ago.

The Age of Hippocrates—The Father of Medicine.—The greatness of the Greek civilization is seen in the real scientific approach to the study of medicine. They did not worship Aesculapius as a God of Healing, but based their system of medicine on Experiment, Observation and Reason. The first complete separation of medicine from religion was effected by the ancient Greeks. The Temples of Aesculapius were converted into hospitals and sanatoria. In 400 B.C. Hippocrates, the greatest of all physicians, brought about this drastic reform of freeing medicine from the obscurantism of priests. The burden of responsibility for disease was taken away from the heads of the Gods and placed on the shoulders of men. He preached that diseases arose on account of man's ignorance and that man's diseases were man's problems and that, therefore, he should find a solution for them by his own reasoning and research. It may be said that the history of medicine really begins from the time of Hippocrates, i.e., from the time of man's acceptance of his personal responsibility for disease. Hippocrates taught that knowledge could be acquired only by observation of the phenomena of 'Nature' and by deduction from the observed and ascertained facts and data. The School of Hippocrates was inspired by the true spirit of medical research. They believed that man is capable of discovering the Laws of Nature by adopting regular scientific methods. Modern Medicine is built up on the principles of science, laid down by Hippocrates. They are: (1) There is no authority except facts; (2) Facts are obtained by accurate observation; and (3) Deductions are to be made only from facts. Science is opposed to dogma or mere opinion. Hippocrates was the first physician to differentiate diseases. He attempted to divert medical thought away from imaginative speculation and broad-base it on common sense and accurate observation. He has well said;

> 'To know is one thing; merely to believe one knows is another;
> To know is Science, but merely to believe one knows is Ignorance.'

The Hippocratic Humoral Theory.—Even though medicine was fairly well advanced during the Hippocratic period, the conception of disease was based on the 'Humoral Theory'. In spite of advanced conception of disease and healing, Hippocrates held that poisonous evaporations from the ground, which he called 'Miasmata', brought about diseases by a derangement of the body humors. According to him, the four cardinal humors, (blood, phlegm, yellow bile and black bile), corresponded to the four temperaments, (sanguine, phlegmatic, choleric and melancholic), (melas, black, chole, bile).

The 'Humors' consisted of mixtures of the four 'qualities' —cold, heat, wetness and dryness. 'Thus the blood, like air, was hot and wet: the phlegm was cold and wet, like water; the yellow bile was hot and dry, like fire; the black bile was cold and dry like earth. The blood arose from the heart, the phlegm from the brain, the yellow bile from the liver, the black bile from the spleen'. A proper balance and mingling of these 'Humors' maintained health; and an imbalance of them produced disease. Faulty mixture or faulty humors, which he called 'Dyscrasia', brought about disease.

According to this speculative 'Theory of Humors', acute diseases were regarded as passing through three natural processes:

(1) a prodromal or crude stage;
(2) a stage of ripening, ('Coction' or 'pepsis').
(3) crisis or resolution; in this stage the diseased material was supposed to be expelled from the body through some natural channel.

But the science of pathology did not make any progress among the Greeks because the postmortem study of disease was prohibited. In the Alexandrian period, dissection was limited to animals for the study of Anatomy only. Though clinical observations on disease had been accumulating, for want of proper postmortem study, much ingenuity was expended to fit the Phenomena of Disease into the purely speculative 'Theory of Humors'.

'The Humoral Theory', reigned supreme for 2,000 years, until it had to give place to Virchow's 'Cellular Pathology'.

The object of the Physician according to Hippocrates.—The object of the Physician was therefore, to seek which 'humors' preponderated and how to restore the balance of the 'humors'. In pursuance of this object, he taught that the physician should rely, to a great extent, on the 'Healing Powers of Nature', ('the *vis medicatrix naturæ*'). His humoral theory, however, being the product of deduction from observation, was no barrier to the progress of medical thought, but acted as a stimulus to further observation and collection of facts. More and more observational facts accumulated and helped in testing the soundness of the theory. The theory may be discarded, when it is no longer useful, but the facts will remain. 'Hippocratic Method' is the origin of the Modern Scientific Method.

Hippocrates worshipped 'Nature' and was learned in the ways of 'Nature'. He is called the 'Father of Medicine'; he is also the 'Father of Physiology'.

The Hippocratic conception of the similarity of the processes of Disease and of Healing.—To Hippocrates, the process of illness and the process of healing meant one and the same thing. To him, 'the symptoms of illness are symptoms of healing'. Alas, very few men of even modern medicine grasp the significance of the above conception of disease and healing. Hippocrates relied on the 'Self-cure of Nature'.—'Nature sanat' (Nature heals).

Hippocrates lived in the great age of Pericles, a period of the highest achievements of the Greeks in literature, government, arts and sciences. He lived shortly before Plato and Aristotle. The impetus given to the proper scientific study of medicine by

Hippocrates lasted only for a period of 300 years. The Greek civilization declined and the progress of medicine was also hindered, by unscientific speculations, taking the place of observation and logic. Physicians were divided among themselves into different schools, holding different theories as to the causation of disease and adopting different methods of treatment. 300 years after Hippocrates, Corinth was destroyed and Greek medicine was transplanted into Rome.

POST-HIPPOCRATIC MEDICINE OF ALEXANDRIA.

The school of Cos in Greece retained its pre-eminence during the time of Hippocrates and only for a short period after him. Medicine, from being a hereditary art, became a practice, which anybody might learn. With the degeneracy of the Greek civilization, there came into being various systems of the healing art, in which theoretical speculations preponderated. The two great philosophers, Plato and Aristotle, are to a large extent responsible for the introduction of theoretical considerations into the healing art. Speculative contemplations have often a tendency to replace correct observation and desire for experiment, thus tending to impede the development of scientific knowledge. The post-Hippocratic period was characterized by subtle theories and dogmatism, which replaced the Hippocratic Method of Observation, Experience and Rational Inference.

After the decline of Greek medicine, Alexandria in Egypt was destined to inherit it. By the conquest of Alexander, the Great, Greek medicine established itself in the School of Alexandria. Alexander made Alexandria a centre of culture and established the famous library, which is said to have comprised of almost a million volumes. Among them there were 400 works of Hippocrates, indeed a great literary legacy. This famous library was burnt down by order of the Emperor Theodosius. He was a Christian zealot, who considered all heathen culture abominable. His act of vandalism has never been surpassed in history.

We are told that in Alexandria there were libraries and museums, botanical and zoological gardens and clinics and hospitals. Great men thronged to this reputed centre of culture in those days. St. Luke, the Evangelist, is stated to have received medical education in the school of Alexandria. The fame of Alexandria rests largely on the fact that it was in this town that the prejudice against the dissection of the human corpse was broken. As a result, Alexandrian medicine was much advanced in its knowledge of anatomy and physiology. But the Alexandrian doctors preached the Hippocratic Theory of disease but forgot that the substance of the Hippocratic teaching was his Method. Higher value was attached to the Hippocratic Theory than to his Method of observation, rational thinking and inference. It has always been a human weakness to mistake the shadow for the substance. The two important physicians of the Alexandrian school were Herophilus and Erasistratus. Herophilus was a distinguished anatomist and he was considered the disciple of Hippocrates, because he professed the humoral theory of disease. Erasistratus, on the other hand, opposed the humoral theory but held fast to the Hippocratic Tradition and Method. He taught that the science of medicine should be based (1) on experience derived from the histories of disease, (2) from actual observations of sick persons, and (3) from analogies drawn between them. He maintained that these three sources of experience should form the 'Tripod' for the practice of medicine. The School of Empiricism was built on this. They rejected the Theory of Humors, because it did not square with observed facts.

Roman Medicine.—This was also derived from Greek medicine. The slaves of Greece played an important part in the transport of the Greek knowledge of medicine to Rome. The Greek slaves freed from slavery began to practise among the Roman peoples. Later on, Cæsar himself granted the civic right of Rome to every doctor; but the Roman Empire did not leave any marked influence upon the development of Medical Science, but the Romans improved surgical technique and laid the foundations for specializing in the various branches of medicine. We learn from history that, in Rome, Eye-specialists, Otologists and Obstetricians practised their respective specialities. The outstanding names in Roman medicine are Celsus and Dioscorides, during the 1st century A.D. and Galen during the 2nd century A.D.

The Theory of Methodism.—The medicine of Rome, as has already been stated, descended from the Greek and Alexandrian medicines. There, a new theory of disease was evolved, known as the 'Theory of Methodism'. According to this theory, all diseases were due to disorders in the natural arrangement of those 'atoms', of which the body was supposed to be composed. Asclepiades held that the 'atoms' were united to form 'pores', through which the fluids of the body were flowing. If these 'pores' were choked, the fluids became dammed up.

His pupil, Themison, carried this idea further. He recognized three states of the 'pores',—relaxation, contraction, and a mixture of both. He taught that it was necessary to determine the condition of the 'pores' in every disease before proper treatment could be given. Like the Theory of Humors, the Methodist Theory compelled the physician to observe the symptoms of his patient. It served the purpose of the medical science by increasing the stock of exactly observed facts.

By the time Galen began to practice medicine, the sum total of observed facts were such that they outstripped hypotheses and would not square with the previous theories, as to the causation of disease. The facts could not be explained in terms of the 'Theory of Humors' or the 'Theory of the Empirics' or the 'Theory of the Methodists'. The Empirics and the Methodists had rejected the 'Humoral Theory'.

Claudius Galenus.—(A.D. 103—200).—He was a native of Asia, but a Roman by adoption. His name ranks only second to that of Hippocrates. He is said to have engaged himself in scientific feuds. He was intolerable to any opinion, opposed to his own. He settled himself in Rome, the capital of the Roman Empire, and the centre of culture at the time. He was a rich and famous physician. He was an authority on medicine and a dictator to his colleagues in the profession. He was the doctor of the famous Philosopher Emperor, Marcus Aurelius, (A.D. 121 to 180). Galen's influence continued for nearly 1,500 years after him. 400 of his medical treatises have been handed down to posterity. Like Hippocrates, Galen was a prolific writer and his works, therefore, are of great historical interest. His works served as the 'Doctor's Bible' for many centuries.

According to him, 'Nature' does not act without a purpose. Disease consequently is a deliberate action, not an unwarranted by-effect. The symptoms of disease are not the expressions of hostile but of friendly healing forces. According to his theory, the symptoms of disease should not be suppressed but, on the contrary, should be furthered or even aggravated, if necessary.

Galen had a good knowledge of the physical and chemical processes of digestion and nutrition. Though he thought that the brain was the seat of the soul, he recognized that it was the centre of all sensations and bodily functions. He laid more emphasis upon treatment than on other branches of medicine. To him the main purpose of the physician was to cure, to make healthy and keep healthy. He taught that the physician should abstain from interfering with 'Nature', when 'Nature' itself sufficed to bring about a cure. Galen recognized that every illness had a beginning, a period of aggravation and a stage of 'crisis', before abatement. He also differentiated between accidental causes of disease and direct causes of disease. Only Galen's name and his ideas continued to receive great admiration, until the time of Paracelsus, the famous physician of the middle ages. It has been said of Galen that he was not only the summit but also the terminus of the medical science of antiquity.

The Theory of Pneuma.—Galen built his hypothesis of the 'spirit' or 'pneuma', which he imagined penetrated every part of the body and was mingled in different proportions with each of the four humors. He taught that the 'pneuma' was subjected to four influences, or 'elements'—heat, cold, wetness and dryness. According to him, health could be adversely affected by faulty combinations of these four influences. 'Distempers' arose owing to the altered 'pneuma' and such 'distempers' were communicated to the 'humors'. He recognized abnormal states of 'humors', as 'Dyscrasias'. He traced these to climatic and other influences, existing outside the body. This theory led him to take a new view as to the nature and action of drugs.

Galen's 'theory of pneuma' also compelled the physician to observe disease processes and symptoms, as he had to determine the state of the 'pneuma' and of the 'humors' and of the external elements, such as, heat, cold and the like, in order to adopt a rational line of treatment. In so far as Galen's theory served as a stimulus to observation and experiment, it was in the tradition of medical progress.

Unfortunately after Galen's time, his 'pneuma' came to be identified with conceptions of religion and acquired a religious sanctity, which was never meant by Galen. With the invasion of Religion into Science, the progress of medical science was hindered. Any criticism of the theory was considered an act of impiety. Observation and experiment were discouraged. Galen, who was trained in the Hippocratic method, would have, if he had been alive, resisted all such attempt to substitute the 'authority of tradition' for that of 'ascertained fact'.

With the fall of the Roman Empire, the Catholic Church rose to power and the Moslem power led to the creation of the Mahomedan Empire. The rise of the power of the Church created the 'age of faith' and the spirit of the age was against science. The Church taught that disease was an expression of 'Divine Displeasure', and that it could be cured, ameliorated or prevented, only through the intermediation of priests. Attempts were made to suppress scientific ideas in Medicine. The 'pneuma' of Galen became associated with the religious doctrine of the soul.

Arabian Medicine.—Schools of medicine arose in many cities of Arabia. There, Hippocratic and Galenic medicine were taught. The Baghdad School became famous, because there the culture of the East, especially from India, mingled with the culture of the West, of the Greeks and of the Romans. The Arabian medicine is characterized by its contributions to materia medica. Pharmacopæas and Apothecaries' shops arose during this period. The Arab doctor enriched knowledge with many contributions to epidemic diseases, such as, small-pox and measles and to the Pharmacopæa. The rapid conquest of Europe by the Arabs contributed to the spread of their medicine as far as Spain. Rhazes' name is famous among the Arabian physicians. As the medicine of the Arabs did not challenge the teachings of the Church and as the treatment of the Arab physicians was more effective, the doctrine of Galen, as expounded by the Moorish and Jewish physicians, did not offend religion or challenge the teachings of the Church. The spread of the Arab medicine gave Europe access once more to Greek culture. The School founded by Jewish teachers at Montpellier was the most famous.

A Brief History of the early Post-Hippocratic Theories of the Nature of Disease.—As has been already stated, the tendency to speculate and formulate theories without sufficient observation or proper experimental evidence, resulted in the origin of many schools among the followers of the 'Humoral Theory of Hippocrates'.

The 'Dogmatists', (Diocles, Praxagoras), emphasized theory. The 'Empiricists' laid stress on previous experience and did not care much for logic or anatomy.

The Theory of 'Plethora'.—Erasistratus (330 B.C.) a prominent member of the Alexandrian School attributed all diseases to a state of 'plethora'. To him 'plethora' meant a stuffing of organs and vessels with an over-supply of nutritive material. To him pneumonia meant plethora of the lungs; arthritis, plethora of joints; dropsy, plethora of the liver, etc. He attributed the results as the causes of the conditions. It was like putting the cart before the horse.

Theory of 'Solidism'.—After the decline of the Alexandrian School, the school of Asia Minor became prominent. Here Asclepiades (124 to 56 B.C.) propounded the theory of 'Solidism' against the 'Humoral Doctrine'. According to 'Solidism', diseases were caused by 'contracted' or 'relaxed' condition of the solid parts. This theory assumed that there was a flow of vital fluids, through an infinity of minute tubes or pores between the particles or atoms, that made up the body. A constriction of the tubes caused acute disease, whereas relaxation resulted in chronic illnesses.

School of 'Methodism'.—After the school of 'Solidism' came the followers of 'Methodism'. The theory of 'Methodism' laid stress on the increased or decreased excretion from the body, but disregarded local symptoms and associated anatomical changes.

The Theory of 'Pneuma'.—The school of 'Pneumatists' came into existence about the year 70 B.C. and lasted for nearly six centuries of the early Christian era. According to them, the 'Pneuma' or 'vital air', taken in by the lungs 'to cool the inner heat of the heart', was supreme. Disease resulted, if the 'Pneuma' was disordered in quality.

School of Eclectics—Theory of 'Dyscrasia'.—The School of Eclectics, who flourished in the first few centuries of the Christian era, appreciated the value of observation and experiment and accepted all the best knowledge in their time, without regard to their source. Among them was Galen. (130–200 A.D.) Though he appreciated the value of observation and experiment and was the greatest medical man of his time, his theory of disease was an extension of the humoral theory, combined with a dominence of the 'pneuma'. To the four 'Humors', he added the three spirits, the Natural spirits, (supposed to flow from the liver to the rest of the body by the veins); the Vital spirit, (from the heart by the arteries); the Animal spirit, (from the brain by the nerves). He divided diseases into three classes. (1) Diseases affecting similar parts or simpler tissues; (2) Organic diseases, (inflammations and hypertrophies affecting compound tissues); (3) General diseases, ('Dyscrasias', due to an upset of the equilibrium of the 'Humor'). According to Galen, health depended on the presentation in proper proportions of the 'Humor' to the various organs and their proper adhesion to them.

The 'Galenic concept of disease' held away for over a thousand and five hundred years. Like Hippocrates, Galen was the most important figure in medical history. The dark and middle ages were bereft of scientific progress and medical thought. The authority of Galen suppressed everything, which did not conform to his theory.

But with the renaissance, came the spirit of revolt. Paracelsus is said to have burnt the works of Galen and Avicenna in the market place of Basel.

The Arabs did not add anything new to the pathological concept of disease. They merely accepted the Greek theory of the four 'humors', made of the four 'elements', and influenced by the three 'spirits'.

Fracastorius, (1478–1583), should be considered as the 'Father' of modern pathology. He entertained remarkable views on contagion. He compared the virus of transmissible disease to the fermentation of wine. He anticipated Pasteur in the conception of the microbic origin of infectious disease. He recognized eight contagious diseases, (Plague, Phthisis, Epilepsy, Scabies, Erysepalas, Anthrax, Trachoma and Leprosy). Typhus fever, foot and mouth disease and syphilis were recognized by him.

The Theory of 'Archeus'.—Paracelsus, (1493 to 1541), was the first openly to oppose Galen. He furthered the use of chemicals in therapy, but he did not further the concept of disease. He promulgated the theory of 'Achæus' or 'vital principle' or the 'essence of life'. He held that this principle was enclosed in an invisible 'Mumia'. What he meant by 'Mumia' is not very clear. The important influence of Paracelsus on his contemporaries was in the revolt against blind authority. He prepared the way for scientific advance through independent observation.

The Iatro-Chemical School—Theory of Vital Forces.—The Iatro-Chemical School was founded by von Helmont. He tried to explain all diseased phenomena as chemical changes. Every bodily process was controlled by a 'blas'. The chemical processes were brought about by a special ferment or 'gas'. The word 'gas' was used in the general sense of 'air'. He conceived of a vital body force, which he called 'Archeus Insitus', and a divine force 'Archeus Infleus'. These two forces regulated both physical and psychical activities. When these forces were upset by the 'idea morbosa', diseases resulted. He, therefore, conceived of disease, not as imbalance of 'Humor', but as an actual though an invisible principle.

Franciscus Sylvius, (1614–1672), of Leyden was a staunch supporter of the Iatro-Chemical School. He propounded chemical theories of body function and recognized the importance of the blood in health and disease. Sylvius contributed to advance in the science of anatomy and in our knowledge of tuberculosis, as he had many opportunities to perform autopsies.

Thomas Willis, (1621–1675), advanced our knowledge of anatomy and also of the pathology of the nervous system. He was the first to observe that the urine in diabetes was sweetish.

Iatro-Physical School.—Opposed to Iatro-Chemical school was the Iatro-Physical school that sought to explain all vital phenomena on the basis of physics.

Thomas Sydenham, (1624–1689) emphasized the value of observation and placed clinical experience above theory. He held to the humoral theory and conceived of disease as Nature's effort to throw off the '*Materis Morbi*', (the morbid material). Each disease was thought of as an independent natural process following a natural course. He believed acute diseases to be due to inflammation of the blood. He attributed chronic diseases to 'Humors', disordered by diet or habits of life. To him, man's disease is due to his own fault.

Hermann Boerhave, (1668–1738), was a follower of Hippocrates and an 'Eclectic'. To him the teachings of the Iatro-Physicists and Iatro-Chemists were both welcome. He recognized the value of post-mortem examinations and published many important descriptions of them.

The 'Animistic' Theory.—The 18th century was characterized by many speculative theories of disease. George Ernest Stall advocated the 'Animistic' theory. He conceived of the '*Anima*' as the 'life force', which governed the activities of the living body and protected it from degeneration. The '*Anima*' normally produced a series of movements in the body to keep the body healthy. These movements took place in the circulatory system and therefore special attention was paid to the increased pulse rate in febrile diseases. When the '*Anima*' was disorganized, disease resulted and when the '*Anima*' left the body or any of its parts, putrifaction resulted.

Theory of 'Motion' and 'Tonus'.—Fredrich Hoffmann, (1660–1742), propounded a new theory that life consisted of 'motion' and death resulted from cessation of 'motion' and that the body was made up of fibres, having different 'tonuses', which made them contract and dilate. This 'tonus' was supposed to be maintained and regulated by an imaginary 'ethereal matter', which had its centre in the brain, from where it sent pulsating messages throughout the body. Disease was supposed to be caused by changes of 'tonus', acute disease being due to spasm and chronic disease to atony. He, therefore, advocated

'Sedatives' in the one case and 'Tonics' in the other. He also believed in disordered humors and excretions. Hoffmann is the greatest of the Iatro-Physicists and is credited with being the first person to perceive that 'pathology is an aspect of physiology'.

Theory of 'Cohesion'.—Jerome David Gaub, (1705–1780), clearly laid down that pathology should treat of 'Disorder of Function as well as of Structure'. He divided pathology into general and special pathology. Causes of disease were divided into the 'Predisposing' and 'Active' and 'Remote' and 'Proximal'. In spite of the growing accumulation of knowledge in 'Pathological Anatomy', he was expounding a modified humoral theory. He considered the body to be composed of a wet mobile substance, an inflammable material and saline and earthy substances. According to him, disease was produced by an improper mixture of these substances. He attributed debility to a deficiency of the natural 'cohesion' between these body matters and stated that excessive 'cohesion' of these matters caused stagnation, obstruction, infarction, etc.

Theory of 'Stimuli'.—John Brown, (1735–1788), postulated the theory that health consisted "in a constant succession of balanced stimuli from the exterior, which, if insufficient or excessive, produced 'asthenic' diseases." To him, opium and alcohol were the panaceas.

A BRIEF HISTORY OF PATHOLOGICAL ANATOMY.

Anatomical concept of Pathology.—Antonio Benivieni, (1440–1502), is considered the 'Father of Pathological Anatomy'. Garrison regards him as the Founder of Pathology, before Morgagni. He performed many post-mortem examinations to determine the cause of death and explain symptoms. Alesandro Benedetti, (1460–1525), was another Italian, who gave a stimulus to the 'anatomical point of view in disease'. He built the Anatomy Theatre at Padua, which was a centre of learning for such illustrious medical men, as, Vessalius, Columbus, Fabricius, Harvey and Morgagni.

The sixteenth century laid the foundation of the Science of Anatomy. Those were the days of 'Universalism' and not 'Specialization'. The same men contributed to different branches of Medicine,—Medicine, Surgery, Obstetrics, Pathology, etc.

Jean Fernel, (1497–1558), published in 1554 his 'Universe Medicina'. This work included Physiology, Pathology, and Therapeutics. He emphasized a rational pathological view point in the treatment of disease. His 'Pathologica Liebri XCII' is considered the 'First Medical Work on Pathology'. Fernel subscribed to the theory of the four humors and to the other implications of that theory.

In the 14th, 15th and 16th centuries, surgeons contributed to our knowledge of pathology, which may be called the 'Living pathology of the present day surgical operations'.

Marco Aurelio Severino, (1580–1656), wrote the 'First Test of Surgical Pathology'. He was also the first to include illustrations of pathological lesions in his books.

Thomas Bartholin, (1616–1680), was a Dane. He wrote his 'Anatomia Practica', in which he collected many pathological findings in different organs, but, unfortunately, all his papers were destroyed, when his house was burnt down.

Johanne Jakob Wepfer, (1620–1695), made many observations, including those on apoplexy, abscess and tumors of the brain. He was a famous physician, who recognized the great value of necropsies.

Thus by the seventeenth century, the anatomical concept of disease and the study of diseased organs were fairly well advanced.

Systematized gross pathological anatomy may be considered to have begun with Benivieni at the end of the fifteenth century. But no collection of systematized morbid anatomical facts was made, until Theophilus Benetus of Geneva, (1620–1689), published his great work—'Sepulchretum Anatomicum sive Anatomica Practica' (1679). This work contained clinical and pathological descriptions of 3,000 cases, collected from the literature, since the earliest times.

Steven Blankaart's, (1650–1702), 'Anatomica Practica' was a record of 200 autopsies. Frederich Ruysch, (1638–1731), published his 'Thesauri Anatomica', which contained not only pathological observations but also anatomical illustrations. He collected for his museum a large number of normal as well as morbid anatomical specimens. His famous museum at Leyden is said to have been purchased by Peter the Great for 30,000 florins and taken to Leningrad.

Joseph Lieutaud, (1703–80), published his 'Historia Anatomica-medica', which was based on 1,200 autopsies, performed at the Versailles Hospital.

The Anatomic concept in Nosology.—Giovanni Battista Morgagni, (1682–1771), is one of the 'Greatest Figures in the whole History of Pathology'. He initiated the scientific study of gross morbid anatomy. He collected a vast amount of pathological material, which he always closely correlated with clinical findings and arranged and analysed it in a systematic manner. By doing so, he was able to draw logical and far-reaching deductions as to the nature of the diseases in question and of disease in general. To Morgagni should be given the credit of having established the 'Anatomic Concept' in nosology and for placing Pathologic Anatomy on a scientific basis as a branch of Modern Medicine.

Morgagni taught at Padua, which was the 'Mecca' for medical men in those days. Morgagni was the 'last of the great Italians', to be a medical focus for the whole world. A regular autopsy technique was drawn up by him.

Antonio Scarpa, (1747–1832), made many anatomical discoveries, which he illustrated very artistically. He also made many pathological observations on hernia, aneurysms, diseases of bones, etc.

William Hunter, (1718–83), was a great anatomist and obstetrician. His collection of specimens is preserved in the Hunterian Museum at Glasgow.

John Hunter, (1728–1793), the younger brother, but a more celebrated person than his brother, William Hunter, collected 13,000 specimens, which are now placed in the Hunterian Museum of the College of Physicians and Surgeons, London.

Mathew Bailey, (1761–1823), was the nephew of the Hunters. His contribution to pathologic anatomy was his book entitled 'the Anatomy of some of the most important parts of the Human Body'. By his time, the science of pathology had begun to be taught as an independent science.

He published an 'Atlas of Pathologic Anatomy', the first of its kind, in which he put in artistic illustrations from steel plate engravings. Bailey's work was translated into a number of languages.

Though Theoretical Speculations continued to be kept up in Academic Pedagogy, by the end of the 18th century, gross pathologic anatomy was established on a firm basis, as an independent branch of medical science.

Marie-Francois-Xavier Bichat, (1771–1802), is to be ranked as one of the Founders of Modern Pathology, along with Morgagni and Virchow.

Tissue Concept of Bichat.—It was Bichat, who gave a new concept to morbid anatomy by his presentation of the various tissues as units,—hence the word 'Histology', (histos, a tissue). 'Histology' gradually acquired the connotation of 'Microscopic Anatomy'. Bichat's work was done without the aid of the microscope. He relied on dissection and treatment of dissected tissues with various physical agents and chemical reagents. Bichat's tissue concepts established tissues rather than organs as the important biological units. His 'Tissue Concept' ranks only second to that of the 'Cellular concept' of Virchow. Bichat distinguished twenty-one kinds of tissues. He described the tissues as the elementary structures, which combine to make up organs and described the organs as units of specific functions. He divided morbid anatomy into two parts (i) General Pathology, which dealt with changes common to each system, wherever located and (2) Special Pathology, which dealt with pathology, peculiar to each region. It was he, who laid stress on this important fact, that *disease of a tissue is essentially the same, no matter in what organ the involved tissue may be.*

Bichat's tissue concept was furthered by Cruveilhier in France and Johannes Muller and Jacob Henle in Germany.

After the French Revolution, French medicine led the world. The French School of Medicine was dominant, until superseded by the German School of Pathologists and Bacteriologists. Bichat's work brought out the important fact that there was *similarity in disorders of similar tissues.*

Corvisart, who wrote a famous book on 'Heart Diseases' in 1806, did 'great service in establishing frequent post-mortem examinations as a means of tracing the development of disease, as well as its end changes'.

Rene Theophile Hyacinthe Laennec, (1781–1826), was the 'Discoverer of Percussion and Mediate Auscultation. His pathologic studies unravelled the many mysteries of pulmonary pathology. He was the 'Founder of the Art of Physical Diagnosis'. He stated that diseases could be distinguished definitely only by their anatomical characters.

P. C. A. Louis, (1787–1872), made careful studies in the wards and mortuaries of the great Paris Hospitals. He was a master of objective observation and statistical analysis. He agreed with Rousseau, that 'truth is in the facts and not in my opinion that estimates them'. He placed the 'Statistical Method' of enquiry as one of the exact instruments of medical investigation.

Andral was the pioneer to emphasize the 'Chemical Study' of the blood in disease.

J. F. Lobstein, (1777–1835), published his 'Traite d'anatomie Pathologique' in 1829. He pointed out that there was *no use trying to look into the dead organ for a rational concept of disease* but that it is necessary to learn the workings of the living organ, exercising the functions peculiar to it. The term 'pathogenesis' was first introduced by him. He emphasized the importance of correlating morbid anatomy with symptoms and pointed out the need for animal experimentation.

Jean Cruveilhier, (1791–1873), published his atlas. 'Anatomy d'Pathologique', containing beautiful lithograph illustrations. This is considered as the greatest work, ever published of its kind.

Richard Bright, (1789–1858), who is well remembered in the disease, to which his name has been given, 'Bright's Disease', was also among the pioneers in England to *correlate bedside observations with autopsy findings*, without the aid of the microscope. But even with the poor histological methods of his day, he accomplished much by his contributions on kidney disease and other-pathological conditions. It is of interest to know that Bright understood the importance of determining blood urea in conditions of uræmia, long before the birth of the new science of bio-chemistry.

Thomas Addison, (1793–1860), is well remembered in the two diseases, to which his name has been given—Addison's Disease and Addison's Anæmia. Claude Bernard discovered the glycogenic function of the liver. Both Addison and Claude Bernard may be considered as the Founders of the Science of Endocrinology.

Johann Fredrich Meckel, (1782–1833), established 'that most *malformations are not the result of mysterious supernatural influence* but represent certain stages in the development of the embryo and of its organs, where growth has stopped or continued abnormally'.

Carl Rokitansky, (1804–1878), is regarded with Morgagni as the greatest of all gross descriptive pathologists. He made pathological contributions of greatest importance. But, it is curious to learn that he promulgated an anachronistic humoral theory of disease. He and his successors, Skoda and Hebra, made Vienna a great centre for medicine. Rokitansky, in his fifty years, is said to have performed over 30,000 autopsies himself. He had accumulated specimens from over 60,000 dead bodies; many of the specimens are still preserved in the Museum in Vienna.

The Theory of 'Dyscrases'.—Rokitansky's theory of 'dyscrases' for every disease or group of diseases was blown up, when Virchow formulated his 'cell theory'. It should be said to the credit of Rokitansky that he accepted the truth of Virchow's criticisms of his theory and gave up his concept of 'crases'. Virchow has written as follows recognizing the greatness of the soul of Rokitansky—'How highly must we esteem the man who could forget and learn so much?; for whom it was not sufficient to recognize his mistakes but who took the trouble to correct them in the light of the more painstaking, methodical researches of his own pupils'. Rokitansky's contribution to Pathology is great. He developed a method of performing autopsies. He emphasized the necessity for viewing diseases from the underlying structural changes in the organs. He was firmly convinced of the great importance of pathologic anatomy, both to the art of medicine and the science of biology.

Hans Chiari, (1851–1916), made Prague the leading centre in Europe for the study of pathology. Theodore Billroth, (1829–1894), contributed to scientific surgery, by emphasizing the need for the study of surgical pathology and general pathological principles to the surgeon. He based surgical procedures on proper pathologic knowledge.

It is a curious fact that, though the Microscope was invented over a century earlier it was not used for the study of Biology and Botany, until well in the 19th century. M. J. Schleiden, (1804–1887), demonstrated that plants are made up of cells, in which the nucleii are important structures.

Theodore Schwann, (1810–1882), established the 'Doctrine of the Cell Structure of Animal Tissue'. He showed the similarity of animal and plant tissues and the basic importance of cells in structure and function. New facts about microscopic anatomy were accumulated in rapid succession. Henley discovered various types of 'Epithelia'. In 1843, Julius Vogel wrote a book on 'Pathological Histology', the first book to be written on the subject.

Rudolph Ludwig Karl Virchow, (1821–1905), has been regarded as the greatest pathologist of all time. He founded the 'Archives of Pathological Anatomy and Physiology and of Clinical Medicine', which has continued ever since as the leading pathological journal. He did not confine pathology to pure morphology, but emphasized the proper understanding of pathological physiology and the relation of pathology to clinical medicine. Virchow established 'the Doctrine of the Continuity of Cell Life' by his well-known axiom, 'omnis cellula a cellula'. On this he based a rational concept of disease mechanism. He demolished Rokitansky's theories of 'crases' and 'blastema'. He also demolished 'Cruveillier's doctrine that phlebitis was the all important cause of disease. He distinguished between the two Leukemias and explained the phenomena of thrombosis, embolism and pyæmia. He established 'the theory of the cellular nature of vital processes', as opposed to the humoral and other theories of such processes. He maintained that the most important symptom of inflammation was 'Functio leisa' (or damaged function). This was a 'dynamic concept'. Virchow's contributions to pathological anatomy and pathologic morphology are very many. He believed in 'Metaplasia'. But he was wrong in his concept of 'Metastasis'. He did not accept the migration of leucocytes from capillaries in inflammation. He denied Darwin's 'Theory of Evolution' and was impervious to the discoveries in Bacteriology and Immunology.

In spite of the above facts, it must be said that it was Virchow's genius, which established the principles of 'Cellular Pathology', which is the greatest advance, which scientific medicine has made, since its beginning. It is to him that we owe the establishment of pathology as a basic science, on which the Science of Medicine should be built up.

Carl Weigert, (1845–1904), was a student of both Virchow and Conhiem. He discovered the differential stains, which enlarged our knowledge of normal and pathologic histology. His another important contribution to pathology was his demonstration that destroyed parenchyma was replaced by an overgrowth of connective tissue.

I have thus traced the 'History of Pathology', from Morgagni's early observations in Morbid Anatomy, through Rokitansky's large collections of pathological material and important contributions to morbid anatomy, to the 'Tissue

Concept' of Bichat, and later to the 'Cellular Pathology' of Virchow, which placed pathology on a firm basis. Organ Pathology became Tissue Pathology and Tissue Pathology again Cellular Pathology.

But, the attention which was successively and profitably focussed on diseased organs, diseased tissues, and diseased cells should in future be bestowed on the still mysterious ferments, fluids, colloidal emulsion, etc., present within the cell itself. The future of pathology lies in the advance of Bio-chemistry.

I propose very briefly to trace the 'History of Experimental Pathology, in this address. The greatest of experimental biologists was John Hunter, (1728–1793). Francois Magendie, (1783–1855), of the French School proved that diseased processes as well as normal function could be subject to experimental investigation. His famous pupil, Claude Bernard (1813–1878), inaugurated a new era in pathology by establishing by systematic experiments that *diseased phenomena could be produced in the living*. Julius Cohnheim, (1839–1884), was the greatest experimental pathologist of the last century. He was the most distinguished pupil of Virchow. Cohnheim emphasized the need for the functional and experimental study of disease and made many important contributions to pathology. He established the phenomena of 'Diapedesis' in Inflammation. Metchnikoff discovered in 1884 the 'Macrophage' and 'Microphage'. Cohnheim propounded the theory that Cancer was due to Misplaced Embryonal Rests.

William Welch, (1850–1934), was a pupil of Cohnheim. The present day prominence of American Medicine and Johns Hopkins Institute is due to Welch. He correlated clinical and pathologic observations. Von Merring and Minkowski produced Experimental Diabetes in the dog. Opie and McCallum contributed to the pathological histology of the Pancreas in human diabetes. The chemical studies were conducted by Naunyn and others. In 1921, Banting and Best isolated Insulin from the pancreas. Exophthalmic Goitre and Myxodema are being investigated in a similar manner by the co-operation of physicians, surgeons, pathologists, bio-chemists, etc.

Rokitansky foresaw that Chemical Pathology will be the pathology of the future. Andral applied blood chemistry to pathology. Leibig was 'the Father of the Science of Organic Chemistry'. Wohler broke the barriers between organic chemistry and biochemistry by the discovery that urea can be obtained from ammonium cyanate. Felix Hoppe-Seyler advanced the science of physiological chemistry. Emil Fisher, (1852–1919), the leading physiological chemist of recent times, has enlarged our knowledge of carbohydrate and protein chemistry. The age-old problems of Inflammation and Oedema have been attacked by bio-chemists and biophysicists with profitable results. The formation of concretions and the mechanism of calcification are being studied. Fruitful results have been obtained by the application of biochemistry to the study of ureamia, diabetes, acidosis, metabolic diseases, etc.

PATHOLOGY IN GENERAL.

'Pathology' is derived from *Pathos*, suffering or disease, and *Logos*, a discourse or study. Pathology is the science of suffering and disease. The real name of the Medical Science should have been 'Pathology', rather than 'Medicine', but the idea in men's minds, that the work of the physician is mainly the administration of medicine for purposes of healing, has been emphasized in that our science has all along been called the Science of Medicine.

Though originally 'Pathology' meant a study of disease, in all its aspects, the meaning had become restricted to the study of the causes of disease and the attendant structural alterations and functional changes.

Pathology should not be confused with merely Pathological Anatomy, which is only a branch of pathology, though only this branch of study was considered important, until recently.

The Anatomical side of Pathology has loomed large, since the middle of the last century. At the present day, we may consider that our knowledge of Pathologic Anatomy is fairly complete. The contributory branches of pathology, such as, Bacteriology and Bio-chemistry, have begun to claim greater attention now than mere pathological anatomy. The wider definition of pathology is not bounded by any circumscribed limits, because it means the study of the nature of disease in its functional as well as structural changes'. The Scientific Clinician is almost identical with the Pathologist. The student of disease has to learn at the bedside, in the mortuary, by the application of physical and chemical methods, by the mathematical or statistical methods, and also by the experimental method.

It is a pity that, in most of the teaching institutions and hospitals, the pathologist should be denied the opportunity of being also a clinician. In most cases, the pathologist is a whole-time officer, whose duties are confined only to the laboratory. In many instances, the departments of pathology, bacteriology and bio-chemistry are made to function as isolated departments under independent heads. The pathological, bacteriological and bio-chemical laboratories should, in my opinion, be under one unified control and that the persons, who are working in these laboratories, should have a living interest in their subject by constant association with patients in the hospital wards. The Modern Spirit of Pathology is expressed in 'Organization'.

Integrated Pathology—Call for Co-operative Effort in Research.—Integrated pathology is a distinct advance in the progress of medical science in the 20th century. The Nature and manifestations of disease should be studied by every possible method of approach—structural, (anatomical and microscopic); the functional, (including chemical, bacteriological, clinical and, whenever possible, experimental). Such a combined attack on the problems of disease, yet awaiting elucidation, has now become the accepted method of approach. A group co-operation of specialists in all the above branches of medicine has, therefore, become very necessary in these days.

The story of the investigation into the parathyroids in relation to tetany and calcium metabolism and osteitis fibrosa cystica, and the story of the pituitary, in relation to acromegaly, Frolich's syndrome, dwarfism and Cushing's syndrome, etc., are all of recent date and well-known to all of you.

So is the story of the vitamins and the avitaminoses—pellagra, rickets, scurvy, etc. The combined contributions of clinicians, bio-chemists and pathologists, are already voluminous. The advantage of correlated study, (integrated pathology), has been well demonstrated in the above important enquiries into the problems of the endocrines and the vitamins.

We may all agree that the day of the philosophic speculative concepts of disease, which are unsupported by evidence, is definitely past. Whatever theories or conclusions are worthy of publication, they should, as far as possible, be based on facts. When such facts are insufficient, the publication should wait for a longer period for more observation and experiment. There can be no system of medicine, which is not based on the well-established principles of pathology and on the scientific methods of pathological investigation.

THE HISTORY OF BACTERIOLOGY.

The Theory of Spontaneous Generation of Disease.—Compared to the 'History of Pathology', the 'History of Bacteriology and Preventive Medicine' is merely one of yesterday. In the olden times, Surgery was attended by great risks and plagues and pestilences swept over every part of the world in periodic succession. Flocks and herds were similarly destroyed. The nature of such epidemic diseases was obscure and mysterious. It was supposed to be due to a 'spontaneous generation depending on cosmic influences'.

The first person to lift this veil of mystery was Louis Pasteur. He was born in the year 1822. Though he was a chemist, learning 'Crystallography' as his special subject, he later applied himself to the study of the 'Processes of Fermentation'. He was requested by the manufacturers of beet-root alcohol to help them in their difficulties in its manufacture. This lead him to the study of 'Alcoholic Fermentation'. In 1857, he published his great discovery that 'fermentation is the result of growth of an organic life, and not due to any action of inorganic matters.

Pasteur concluded that 'fermentation is a phenomenon of life'. The discovery of living 'globules' as the cause of fermentation, and that, in their absence, there was no fermentation, was a very great discovery, which lead later investigators to peep into the 'world of the infinitely small.' As in fermentation, so in souring of wine, in souring of milk, in decomposition of butter and in the processes, in general, of decay and putrifaction, a vast 'underworld of life was shown to be the cause '.

Pasteur promulgated the doctrine of immortality of the infinitely small, in the face of severe opposition. He stated that 'if the processes of change and decay are indeed processes of life, there must exist in 'Nature' innumerable tribes of living things, eternally active, capable of limitless reproduction. He gave the quietus to the doctrine of spontaneous generation.

Bacterial Concept of Disease.—His discovery lead to the trailing of the 'Foes of Disease', hidden during all the previous ages. Pasteur, like a crusader, entered the 'Citadel of Disease' and tracked the causes, one after the other, of the silk worm plague (Pebrine), Fowl Cholera, Anthrax, Hydrophobia, etc. Just as he conferred the greatest benefit to the wine growers of his country, his contribution to the success of silk industry was equally great.

After discovering the bacillus, which is the cause of Anthrax, Pasteur observed that his cultures of the Anthrax germ, if kept exposed to air, lost their virulence. He seized on this knowledge, prepared a vaccine, and injected healthy sheep and oxen and found that these vaccinated animals became immune to the disease. This was the beginning of the 'History of Preventive Medicine'.

Pasteur should, therefore, be considered as not only the 'Father of Bacteriology' but also of 'Preventive Medicine'. Pasteur saved France also from loss of the wool industry by the preventive innoculation against anthrax.

The discovery of the causes of anthrax and fowl cholera and also the discovery of their prevention by preventive innoculation made Pasteur realize the great possibilities of his discovery for the protection of man from infectious diseases. Pasteur's work on hydrophobia, therefore, followed naturally on his work on anthrax. He used emulsions of the spinal cords of rabbits, infected with the virus of hydrophobia, for the treatment of hydrophobia. He was lead from the 'world of the infinitesimally small', (micro-organisms), into the 'world of the infinitesimally smaller', (ultra-microscopic viruses). He showed that there were but two ways of offering resistence to pathogenic bacteria, namely, the destruction of the bacteria and the increase of the resistence of the body against them. Pasteur discovered both these ways and applied both the methods, to fight disease in man and beast. The sciences of bacteriology, immunology and preventive medicine, which were founded by him, have changed the face of the world at the present day. To Pasteur must be given the whole credit of relating bacteria to the phenomena of disease, though micro-organisms had been observed long before his time by Leeuwenhoer in the 17th century.

In the meantime, Jenner had discovered the effect of vaccination as protection against the attack of small-pox. These wonderful discoveries of Pasteur and Jenner formed the basis of all subsequent developments in preventive medicine. The greatest benefactor to humanity in the 19th century was the greatest Frenchman, Pasteur. He will be remembered to be so for ever more.

Joseph Lister, professor of surgery at the Glasgow University, wondered what the cause might be for wounds, becoming septic, and for blood-poisoning. He first accused the air, which was polluted with smoke and stench, and the site of the hospitals. By an accident, he read an article of Pasteur in a journal and began to wonder what possible connection could exist between wine and wound. He wondered why ordinarily a simple fracture healed up, without septic complications, whereas the average compound fracture invariably became septic, often resulting in the death of the patient. He started using 'carbolic acid spray for killing germs'. This was the birth of the 'Antiseptic Surgery'. Pasteur's discoveries helped Lister to effect a complete 'Conquest of Wound Fever'. Antisepsis was later superseded by the aseptic method in surgery. Surgery has, therefore, now become bold and fearless in its methods.

The Hungarian physician, Semmelweiss, was ignorant of the microbic origin of disease but has anticipated its application in midwifery.

The discoveries of Pasteur and Lister made their followers seek the cause of every disease in a microbe. The body was looked upon as a fortress, surrounded by microbic enemies all round. Jenner and Pasteur had also pointed the way towards strengthening these defences. Thus, between 1818 and 1890, the causative organisms of a large number of diseases were discovered. The greatest bacteriologist of the time was Robert Koch.

The discovery of many of the most important pathogenic bacteria was made by Koch. He was the discoverer of the tubercle bacillus and the cholera vibrio. This enlarged the foundations of modern bacteriology. Not only did he identify the causative organisms but also described their biological properties and the properties of their toxins. He discovered the tuberculin and made use of it for diagnostic and therapeutic purposes. He was the first to prepare transparent solid culture media. He made researches on rinderpest, plague and trypanosomiasis. His discovery of the causative organisms of many dangerous diseases earned him the 'Nobel Prize' in 1905 and 1906.

To von Behring and Kitasato belongs the credit of the discovery of the antitoxic sera. The serum, that has afforded the most excellent results, is the antidiphtheretic serum. The prophylactic use of anti-tetanic serum was later well established. A further application of this serum therapy is seen in the recent attempts to treat measles by injecting the blood from a patient, newly recovered from the disease. Only, in this disease the supply of serum is limited to the amount, which can be made available from human sources. The value of protective vaccination against typhoid and para-typhoid has now been well established.

The preparation of a vaccine for bacillary diseases was comparatively an easy matter, but it is not so, for the virus diseases. But the work done on dog's Distemper justifies the belief that the vaccine treatment for virus diseases is possible. It is now known that influenza, measles, whooping-cough, mumps, chicken-pox, and small-pox in man and many similar diseases among animals and plants are due to viruses. We are beginning to get just a glimpse into 'the world of the infinitesimally smaller.

Metchnikoff, (1845-1916), is the 'father of one of the most important theories of Immunity'. He was the 'discoverer of Phagocytosis'. He was also the recipient of the 'Nobel Prize' in 1908. Almroth Wright gave a new orientation to scientific thought. He showed that curative vaccination in acute diseases, as opposed to preventive vaccination, will lead to disappointment.

Wright's studies, by directing attention to the mechanism of bodily reactions, have served a valuable purpose. The discoveries of Metchnikoff and Wright have shown us that the body is armed with formidable weapons against disease. Schaudinn in 1906 discovered the organism of Syphilis and a year later, Wassermann, (1866–1925), discovered the Sero-Diagnostic Method for Syphilis.

Biochemical Theory of disease.—Paul Erlich is the 'Founder of Hæmatology'. He discovered his tri-acid stain, diazo reaction of urine, intra-vital staining, etc. His monumental works are on dye stuffs and on the chemical explanation of immunity, (the side-chain theory) and in the discovery of salvarsan, in collaboration with Hata, his Japanese assistant. The works of Erlich have changed the direction of modern medicine from the bacterial to the biochemical theory of disease. Erlich's discovery of Salvarsan obscured for a time the importance of the mechanism of bodily reaction in disease. It was vaunted that salvarsan could kill the spirochæte, without inflicting any injury upon or causing any distress to the patient. 'Nature' was thought to be a mere spectator to the rout of the spirochetes by the drug. The truth has now become clear that the drug acts, in the first instance, not on the spirochæte but on the body itself. It is the body, thus stimulated and not the drug, which effects the cure. The impression, that quinine in malaria tracks out the malarial parasites and kills them, has been shown to be wrong. It is by its power to stimulate the body, that quinine helps to kill the malarial parasites, A similar process appears to exist in the action of antiseptic such as, Flavine. We thus see that the body mechanisms of defence are of great complexity, many of which are but little understood. Our attempts in the treatment of diseases should be only to summon and help the powers of 'Nature', never to replace them.

In 1880, Laveran observed the parasite in the blood of patients suffering from malaria. Laveran's discovery was not noticed, because it was not known how the parasite gained entry into the human body. Wucherer, Lewis and Bancroft described filariasis and the small worms in the blood of patients, suffering from the disease. Sir Patrick Manson ingeniously suggested the probable association of mosquitoes with filariasis, as he argued that the agent of infection must operate at night. His conjecture proved true. He showed that the embryos were imbibed with the blood by the mosquito and that they reached full development in its body. G. C. Low showed that the embryo filariæ passed into the proboscis of the mosquito and he suggested that the mosquito carries the disease from one human being to another directly and without the intervention of water, as was believed by Manson. The discovery of Manson and Low of the mosquito transmission of filaria was the 'Foundation Stone of the Edifice of Tropical Medicine'. The importance of their work lay in the demonstration, that 'Insects act as Carriers of Disease'.

Manson also suggested that a mosquito might prove to be the carrier of malaria and was the inspirer of Ronald Ross in his great discovery. The proof of the Mosquito Malarial Theory by Sir Ronald Ross is one of the 'most inspiring records of human endeavour'. The discovery of the particular species of mosquito as the carrier of malaria laid the foundation for the whole subsequent development of tropical hygiene.

The Reed Commission demonstrated in 1900 to 1901 that Yellow Fever could be induced in healthy men by the bite of a certain species of mosquito. The infected mosquito remained infective during the rest of its life of nearly two months. The discovery of the cause of malaria and yellow fever lead to a remarkable development in the detection of the carriers of other diseases. Bruce discovered micrococcus melitensis as the cause of Mediterranean Fever and traced it to infected goat's milk. He also discovered Trypanasomes in the blood of domestic animals infected with the disease, known as 'Nagana'. He suggested a similar cause for 'Sleeping Sickness'. In 1902, Dutton discovered trypanasoma gambiense and in 1910, Stephens and Fanthan discovered trypanasoma rhodhesiense and incriminated the Tse-Tse Fly, *Glossina Palpalis*.

Kitasato and Yersin discovered the causative organism of Plague, the bacillus pestis. In 1908 the Indian Plague Research Commission disclosed that bubonic plague in man is entirely dependent on the disease in the Rat. They showed that sanitary conditions have no direct relation to plague, except in so far as they favour infestation by rats. The recent work of Martin of the Lister Institute has shown that the method of infection by the flea is a 'contaminative method' and that the vomit of the infected flea, containing bacilli, infects the area of the flea bite.

In 1907, it was discovered that Relapsing Fever was conveyed by Lice. In 1909, Typhus was proved to be a louse borne disease. During the last war, Byam proved that Trench Fever is also carried by lice.

Leiper in 1916 showed that the parasite of Biharziasis passed a period of its development in the body of a Water Snail.

Noguchi.—Hideo Noguchi was the most brilliant Japanese research worker of this century. His researches on original lines were enormous. He made many serological studies. He was the first to culture the organism of syphilis. He demonstrated the presence of these organisms in the spinal cord in patients suffering from tabes and in the brain of patients in general paralysis of the insane. He proved the syphilitic nature of both these affections. He discovered the organism of yellow fever and of Wiel's disease. The volume of his researches has given him 'a place in the fore-front among the great scientists of the world'.

The technique of Tissue Culture, originally formulated by Harrison and Carrel, has greatly facilitated the study of the growth of different types of cells and tissues and the effect of various chemical, physical and other influences on them.

The researches into immunity reactions began from the discoveries of Pasteur, Koch, Erlich and Metchnikoff. The chemical and physico-chemical reactions in the immunological processes were studied by Erlich, Bordet, Madsen, Arrhenius and others. The practical application of these studies is seen in the employment for diagnostic purposes of the Widal Test, Wassermann Test, etc.

A Brief Summary of Contributions to the science of Pathology by the Medical Research workers in India.—As the field over which medical research has extended in India is very wide, I shall only very briefly mention the important contributions, made to pathology (including its branches of bacteriology, parasitology, helminthology, etc.).

Among the earlier classical studies may be mentioned those of Lewis on trypanasomiasis; Vandyke Carter on spirilla, leprosy and mycetoma; Macnamara on cholera and Fayrer on snakes and snake venoms. Organized medical research dates from 1894, when the Indian Science Congress moved the Government of India to establish and endow a Research Institute.

In India research work is mainly conducted in the following Government institutions. The Plague Research Laboratory (later called The Haffkine Institute) was established in 1899. The Bacteriological Department was formed in 1905. In 1906, the Central Research Institute was established at Kasauli, and the Pasteur Institute at Coonoor in 1907, Rangoon in 1915 and Shillong in 1917. In 1920 the School of Tropical Medicine and in 1932 the All India Institute of Hygiene and Public Health were opened. An important milestone in medical research in India is the creation of the Indian Research Fund Association.

Malaria.—Malaria, being the major health and social problem in India, received naturally a large amount of attention from medical research workers. It was in India that the mosquito was incriminated as the carrier of malaria by Sir Ronald Ross at the close of the last century. But earlier in 1845, Dempster introduced the Spleen Rate as a measure of malarial endemicity. Giles, James and Liston studied the mosquitoes. Christophers enunciated the principle of 'Species Sanitation'. Much work has been done on Entomology by subsequent workers —Adie, Donovan, Patton, Turkhud, Barraud, Senior White, Strickland, Iyengar, Sinton and others. The epidemiological studies of Christophers and Bentley showed that the causative factors in the production of malaria were very diverse.

The Central Malaria Bureau and then in 1926 the Malarial Institute of India were established. Much work has been accomplished in epidemiology, control of rural malaria and on the bionomics of various anopheline vectors. Among other workers on malaria may be mentioned Bentley, Gill, Acton, Knowles, Krishnan, Das Gupta, Rao, Iyengar and others, and also Sweet and Russell of the International Health Division of the Rockefeller Foundation. Krishnan's researches on monkey malaria and black-water fever will throw a new light on malarial immunity. Shortt's studies on protozool immunity are worth recording. Tirumurti, has shown that malaria and dysentery are not the causes of cirrhosis of the liver, as it was believed to be for a long time.

Cholera.—India is the main endemic home of cholera. It has been, therefore, a subject of considerable attention and study. Koch confirmed in India his discovery of the comma bacillus in 1884. Since then, much work has been done on the epidemiological, preventive, clinical and treatment aspects of the disease.

Greig studied the pathology and bacteriology of cholera. He found that there were many vibrios resembling vibrio cholera, but nonpathogenic. Tomb and Maitra studied the bacteriology of cholera and the carrier problem.

In 1928 de-Herelle studied the bacteriophage in relation to cholera. Malone, Morison, and Asheshov took up the bacteriophage question in relation to the vibrio and the prophylactic value of cholera bacteriophage.

Rogers and Russell and Sundararajan made epidemiological studies to forecast epidemics of cholera. Other workers produced a prophylactic anti-cholera vaccine.

At present work is in progress on the chemical constitution of vibrios, its metabolism, bio-chemical reaction, variations in vibrios, etc. Different serological types of vibrios have been isolated. Vibrios have been isolated from healthy persons and external sources. Agglutinable and non-agglutinable vibrios have been differentiated. It has been shown that, by the use of suitable methods, vibrios can be isolated from practically all open water sources in India. These studies will show the possible origin of vibrios, which can be isolated from man, in health and disease. Pasricha, de-Monte, Lahiri, Chatterjee and many others are engaged in the Cholera Enquiry.

Plague.—Plague was introduced from China into India in 1629, though India had been free from plague for 2 centuries previously. Bombay was the first city to be affected, from where it spread to other parts of the country. It was at first supposed that the disease was transmitted from man to man. On this theory of transmission preventive measures were applied. Naturally, they were completely ineffective and gave rise to considerable amount of suffering to the people and to protests and agitation in the country.

The Plague Research Commission was formed in Bombay in 1905 and worked until 1913. It is to this commission that we owe our exact knowledge of the epidemiology of plague.

Hankin had suggested the possibilities of insect transmission of plague from rat to man but to Liston belongs the credit of proving the flea transmission of plague. Subsequent work showed a flea species factor influencing the epidemiology. Haffkine produced the prophylactic vaccine. This is one of the first prophylactic vaccines to be used on a large scale in man.

Attempts are now made to improve the vaccine and produce a potent anti-plague serum. In this connection the names of Naidu and Sokhey may be mentioned. The carry-over problem of plague is being investigated in the Cumbum valley. It has been shown that meteorological conditions do not affect the fleas in the rat burrows and that hydrogen cyanide gas is the best lethal agent for the rats and fleas in the burrows. Epidemiological studies have shown that the immunity of the rats for plague is roughly proportionate to the degree of incidence of plague in the areas, from which they were collected.

Kala Azar.—In 1903, Leishman recorded the discovery of the parasite in a spleen smear. So had done also Ross. But, independently of them, Donovan found the parasite in the spleen puncture smears of deceased individuals and also in the peripheral blood smears. Christopher gave a classical description of the pathology of Kala Azar in 1904 and 1905. In 1904, Rogers cultivated the parasite and showed that it was a flagellate. In 1907, Patton discovered that the parasite assumed the flagellate form in the bed bug. In 1913, Mackie suggested the genus Phlebotomus as the possible Vector. In 1915, the tartar emetic treatment for Kala Azar was introduced by Rogers.

In 1917, Brahmachari discovered the globulin precipitation test; in 1921, Spackman introduced the formal-gel test for Kala Azar. It was popularized by Napier. In 1922, Brahmachari introduced Urea Stibamine, as a specific for the disease. From that time the modern treatment for Kala Azar may be said to have begun. Chopra's serum antimony test made the diagnosis easier.

In 1922, Brahmachari discovered Dermal Leishmaniasis. In 1923, Shortt and Brahmachari described the pathology of the disease. In the same year Shortt demonstrated L.D. bodies in the urine of Kala Azar patients. Shortt was the first to suggest P. Argentipes as the Vector. Knowles, Napier and Smith in 1924 showed that L.D. bodies flagellated in the insect's gut. Shortt, Smith, and Krishnan discovered the technique of giving sand-flies a second and subsequent feeds. In 1926, Shortt and his colleagues found massive natural infection in the buccal cavity of P. Argentipes. In 1927, they infected a mouse with the gut contents of the infected sand-flies. In 1923, they infected hamsters by the oral and conjunctival routes. In 1928, they described the presence of L.D. bodies in the faeces. In 1930, they showed that the disease was transmitted from infected hamsters to healthy hamsters by close contact.

Lloyd and Paul described the serum changes. De Silva and Swaminath confirmed the identity of the parasites of K.A. and Dermal Leishmaniasis.

In 1931, Shortt, Smith, Swaminath and Krishnan recorded the first successful transmission of K. A. to a hamster by the bite of an infected P. Argentipes. In 1935, Shortt and Swaminath recorded the finding of L.D. bodies in the nasal mucus of K.A. patients. With the infected mucus they successfully infected a hamster.

Leprosy.—Until 1920, no attention was paid to research in leprosy. Rogers made a clinical study of the disease and tried various preparations of Chaulmoogra oil in treatment. Muir and his co-workers took up later the epidemiological, clinical, pathological and bacteriological studies on leprosy. The types of leprosy were clearly defined. The self-limiting character of the disease was pointed out. The view that leprosy is a highly infectious, always progressive and fatal disease was proved to be wrong. It was shown that children have poorly developed immunity to leprosy and that the solution of the problem of prevention lies in the removal of the children from their diseased parents; in the segregation of the infected parents in institutions for their care and treatment; and in their sterilization, if possible. Much work is being done on rat leprosy, though neither human nor rat leprosy bacillus has so far been cultured, in spite of repeated attempts on new lines.

Rabies.—Semple in 1911 first introduced the dead carbolized antirabic vaccine. Harvey and Acton showed that the results from this carbolized vaccine were better than those from the use of the original Pasteur vaccine, made from the dried cord. The introduction of the carbolized vaccine made possible its preparation also in the plains and the decentralization of treatment. Anti-rabic treatment is now given in most of the important cities. McKendric and Cornwall did research on the pathology of rabies and the accidents in treatment. Cunningham in 1927 introduced the carbolized vaccine made from fixed virus brain substance. Studies are in progress on the value of anti-rabic serum and the combined use of serum and vaccine.

Nutrition Research.—In 1912, McCay published his book on the 'Protein Element in Nutrition', when he was the Professor of Physiology in the Medical College, Calcutta. This was the first work to draw attention to the relation between diet and physique. McCarrison (1913 and 1914) showed the effect of faulty food on the thyroid gland. Later, he studied the pathological changes, caused by defective diet in most of the organs of the body. The nutritive value of food stuffs is being investigated. Aykroyd has succeeded McCarrison as the Director of the Nutrition Research Laboratories, Coonoor. It is at present one of the largest institutions in the world, devoted solely for nutrition research. Keratomalacia, Stomatitis, and Epidemic Dropsy are under investigation.

Other Subjects.—Many contributions have been made on general protozoology, medical entomology, helminthology, snake venom and indigenous drugs. It is not possible in this address to cover all the ground. Col. Chopra has founded Pharmacological Research in India in the School of Tropical Medicine, Calcutta, and has made very many important contributions.

No research on cancer was undertaken until recently. We owe to Vishwa Nath much of our knowledge regarding its prevalence, age distribution, sex incidence, order of frequency, as regards site, etc., in India. He has exploded the dogmatic statements of foreign medical men about the rarity of the disease in India. He has shown that the age of maximum incidence of cancer in India is at least ten years earlier than in the Western countries and that the incidence of cancer of the cervix falls heaviest on Hindu women and Buccal Cancer is more in men than in women and in the Muslims than in the Hindus.

For much of the information in this brief review, I am greatly indebted to the recent publication of 'the *Indian Medical Review*' by Major General E. W. C. Bradfield, D. G., I.M.S. 'A reference may be made to it for fuller details on the subject of Research in India'. The book is a mine of information to medical men in India and elsewhere and such a book was long over-due.

A Brief Summary of India's Contribution to Veterinary Pathology, (including protozoology, helminthology and entomology).—The scope for Veterinary Research in India is large and during the last decade considerable amount of work has been done, notably in Veterinary Helminthology and to some extent in Veterinary Protozoology and Entomology.

In the field of the contagious and epizootic diseases, the notable improvement is the use of the Goat Spleen Tissue Vaccine in the control of Rinderpest in cattle. This method of vaccination has been evolved from the discovery of Edwards, that Rinderpest virus can be fixed and reduced in its virulence for the ox, by passage through a series of goats. For the poor cultivator of India, whose very existence depends on his cattle, this discovery has been a boon in fact. There are other diseases, such as, Hæmorrhagic Septicæmia, Black Quarter and Anthrax, against which anti-sera and vaccines are being used, but it seems necessary that more work has to be done to evolve a more satisfactory method for their control.

Progress has been made in the study of protozoa, pathogenic to live stock in India. Ray, at Muktesar, has recently described a piroplasm, which resembles Babesia bovis; Sen has described in cattle Babesia annulata, which is believed to be pathogenic. Ray has described a new species of Bartonella in the dog. Shortt and Swaminath have elucidated the life-history of Babesia gibsoni of the dog. They found that the tick, hæmaphysalis bispinosa, is the vector concerned. Ray of Muktesar has redescribed the morphology of B. gibsoni.

It is interesting to note that the research of these workers has confirmed Rao's findings published as long ago as 1926.

The first trypanosome, known to be pathogenic to animals, was discovered in India by Evans and there have been some controversies whether that trypanosome, T. evansi, was actually the cause of outbreaks and deaths in cattle, as it is in other domesticated animals, like the horse, the dog, etc. The researches of Edwards, Sen and Rao seem to confirm that T. evansi is as pathogenic to cattle as it is to other animals. Rao holds that cattle are not the accredited reservoirs of T. evansi, like camels in North India. The study of this protozoon will not be complete, unless its life-history, which at present is not known, is worked out. In Africa almost all the trypanosomes have a vector in Glossina, but in India, biting flies, like the Tabanus, do not play the same role as the Glossina in Africa. There is yet another trypanosome, T. theileri, about which very little is known here.

At Madras Valladares and Rao have obtained some evidence to show that sometimes it is pathogenic to cattle and causes symptoms as in piroplasmosis.

Datta working at Muktesar on the Hill Hæmaturia of Bovines has adduced some evidence to show that it is caused by an amœba, which he calls E. Kamala.

Turning now to Veterinary Helminthology, I feel proud to say that a large share of the work has been done in Madras. The most notable researches seem to be in Bovine Nasal Schistosomiasis. Rao, Datta and Malkani seem to have simultaneously discovered that the so-called bovine nasal granuloma is a true nasal schistosomiasis. Rao and Datta described in some detail the histopathology of the lesions and the eosinophile character of the so-called 'clubs and granules' formed around the refractile schistosome egg shell, containing larval remnants, or even a fully developed miracidium. The so-called 'clubs' have been explained as the manifestation of the host's protective reaction. It is interesting to note that Rao has demonstrated the so-called pseudo-tubercles of schistosoma origin in the growths of horns of cattle and maintains that one of the etiological factors of horn cancer in cattle may be the nasal schistosome. Datta has rightly pointed out that most of the outstanding contributions regarding the nasal schistosome are contained in a series of articles by Rao. With carefully planned transmission experiments Rao has definitely proved that the nasal schistosome is a new species and that Sewell's cercaria Indica XXX is the larva of that species.

Datta found that one of the causes of 'Persistent Debility' in horses in India is associated with nodulated calcareous lesions in the liver, caused by the ova of schistosoma indicum.

Chandler, while working in North Bengal, described a schistosome egg in fæces collected from defæcating areas and believing it to be from man considered that it was a new species affecting man. He named it S. incognitum. In 1933, however, Rao discovered a new schistosome in the pig, whose ova are exactly like those described by Chandler. Rao has endeavoured to show the mistake Chandler has made in believing the fæces he collected was from man and because the name S. incognitum is a nomen nudum, the name S. suis has been suggested. The discovery of this in the pig is interesting, because, unlike S. japonicum, which parasitizes the pig and man in the Far East, this worm does not affect man in India. It, however, affects dogs and Rao has shown that it is one of the causes of dysentery in dogs.

As regards other trematodes, Bhalerao has found that *Limnea Acuminata* is the intermediary host of the Indian liver fluke—*F. gigantica*. Rao found that *P. exustus* and *L. luteola* to be the molluscan hosts of *P. cervi* and *F. elongatus*. Besides these Rao has described some larval trematodes new to science in addition to what Sewell has described in his valuable monograph, Cercariæ Indiæ. Rao has recorded lung flukes, *Paragonimus westermani*—from dogs.

Coming now to the nematode parasites, the important discoveries are by Panda and some others. Panda in Assam found that the cause of Hump sores in cattle was parasitic. He described a new nematode, Stephanofilaria assamensis, which is the cause of hump sores. Krishna Iyer discovered that the so-called periodic ophthalmia in horses was a micro-filaria similar to the ophthalmia, associated with guatemala nodules of man, but the adult worm remains undiscovered. It is possible that the adults are onchocerca. At Muktesar a new type of cutaneous affection in cattle caused by micro-filariæ has been studied and more work on this is awaited. A fairly large number of nematodes, some of which are new to science, have been recorded in this country and time does not permit me to detail them here.

As far as I could gather, many tape worms have been studied in India, and some of the new ones have been recorded from poultry, but from larger animals very few cestodas have been recorded. It is interesting to note that Rao and Vaidyanatha Mudaliar have recorded Diplopilydium nolleri from the cat and Pseudo-anoplocephala crawfordi from the pig, respectively, in South India. It would appear that tape worms have not received sufficient attention in this country.

As regards Veterinary Entomology, it is gratifying to note that some interest has been evinced in that subject. Sen has recorded the presence of Ornithodorus megnini, the spinose ear tick, in the Central Provinces. Sohni, working on warble flies, has deduced some important points in their life-history and he has also shown that ticks cause as much loss to the hide industry as warbles. Rao working on the cutaneous myiasis of animals has confirmed the work of Patton that Chrysomia bezziana is the fly responsible for that condition.

In conclusion, I may say that Rhinosporidiasis appears to be yet another disease, which can be classed among those diseases common to man and animals in India. Tirumurti published an exhaustive account of the clinical and pathological appearances of the Rhinosporidal growths in man in the nose and other parts of the body and suggested to Krishnamurti its possible occurrence in domestic animals. Krishnamurti was the first to record the parasite in the nasal lesions of bovines and ponies in South India and his work has been confirmed by Rao. Rao has shown that the organism affecting man and animals is the same and he has also discussed the probable modes of infection. It is interesting to note that last year Shahi discovered the Rhinosporidium in the nasal lesions of a pony in the United Provinces. So far, this condition has been found in bovines in South India and now that its presence has been noted in a pony in North India, it may not be long, before it is found there also in cattle.

THE NEED FOR HISTORICAL APPROACH TO THE STUDY OF MEDICINE.

Having been a teacher of pathology for some years, I have become increasingly convinced that a historical approach to the handling of the subject is very necessary, and that every teacher should know the History of Medicine and also the History of his Special Branch of Medicine. I am not a medical historiographer. Neither have I made any special study or research on the History of Medicine. I had only to depend for this address on the information, which I could obtain from various sources. I have drawn liberally from Krumbharr's Pathology in the series 'clio Medica'. I should prescribe this little handbook to every medical student, who comes into the third year of his studies. Having now become acquainted superficially with the History of Pathology, I wish I could begin my career as a teacher now; but I am old and shall have to retire from office soon. Nothing will give me greater pleasure than to find that this address of mine has pointed the way, in however poor a manner, to medical students and teachers to the rich storehouse of knowledge, gathered in books on the History of Medicine and its branches and to the still unexplored field for research in this country.

THE FUTURE PROGRESS OF MEDICAL SCIENCE.

The brightest chapter in the History of Pathology is the period, which began with Pasteur. It is glorious and fortunate to live in these days, when exact knowledge in the Science of Pathology, (including Bacteriology, Protozoology, etc.,) has placed weapons of great power in our hands for the prevention and the cure of a large number of preventible diseases. No progress is possible without exact knowledge.

The most important part of the medical sciences, which have given the world to-day the healthiest period, it has ever known in its history, is pathology, including bacteriology, protozoology, etc. The study of pathology has become the basic discipline of scientific medicine and shall continue to be so for evermore. What has been accomplished is small in comparison with future possibilities of preventing suffering and prolonging life. Prophylaxis is taking the place of therapy. It is literally true that man controls his own destiny. Medical science can progress only so long as the scientific spirit survives. The Test of Civilization may well be Standard of its Scientific Spirit. 'Research' is the watchword of modern medicine. 'Empiricism' is the refuge of 'Ignorance'. 'Medicine and

Civilization advance and progress together. The conditions essential for advance are intellectual courage and a true love for humanity. It is as true to-day, as it has been in the past, that further advance or even the holding of what has been won depends upon the extent, to which Intellectual courage and Humanity prevail against Bigotry and Obscurantism'.

'We stand upon the intellectual shoulders of those medical giants of bygone days and because of the help they afford us, we are able to see a little more clearly than they were able to do'. (Claude Bernard).

SECTION OF AGRICULTURE

President:—RAO SAHIB T. V. RAMAKRISHNA AYYAR, B.A., Ph.D., F.Z.S.

Presidential Address

INSECTS AND THEIR RÔLE IN INDIAN AGRICULTURE

CONTENTS.

Page

1. Introduction 272
2. Animals and Man 273
   Mutual relations from prehistoric periods—Study of these relations—Economic Zoology.
3. Insects (Entomology) 274
   Status of insects among animals—Some of their striking characters as regards life history, habits and some remarkable traits.
4. Insects and Human Interests (Economic Entomology) .. 277
   Popular classification of Insects—Beneficial and Injurious forms.
5. Extent of Damage and Loss caused by Noxious Insects (Agr. Entomology) 279
   Major and minor pests—Statistics of loss caused to farmers through insects.
6. Pest Outbreaks and Factors influencing them 282
   Balance of life in Nature—Factors maintaining and upsetting the balance—Work of human agency.
7. Nature and Range of Insect Injury and Incidence .. 284
   Symptoms of insect injury to crops—Pest categories—Insect pest calendars.
8. Some Insect Problems connected with Agriculture in India .. 288
   Pest surveys—Insect K.D.s—Some all-India problems—Some local problems.
9. Insect Pest Control in India. Faith and Magic Cures .. 293
   Modern scientific methods. Preventive measures—Chemical methods. Biological methods—Legislative methods.
10. Some Observations and Suggestions 306
    Importance of Systematic work—of Ecology and Bioclimatics—Men, methods and organization for work. Co-operation between different workers—Pure and Applied Biology in India.
11. Conclusion 314

INTRODUCTION.

LADIES AND GENTLEMEN,

I feel it my first duty this morning to express my deep sense of gratitude to the executive of the Indian Science Congress Association for the honour conferred on me by selecting me as the President of this section for the current year. Apart from my fitness or otherwise for this distinction I certainly consider it a unique honour to be asked to preside over the deliberations of a very important section of the Science Congress like Agriculture and to be allowed the proud privilege of becoming associated with the numerous distinguished scientists who have graced this chair till now. In spite of all the possible defects I may possess, with the valuable co-operation and help I am sure of getting from you, I hope to carry on the duties allotted to me and endeavour to justify the trust placed in me.

The problems of the Indian farmer are, as all of us know, so numerous that it is practically impossible to satisfactorily deal with or even briefly survey every one of them within the compass of any single address with all its inevitable limitations. In my opinion the best and the most appropriate theme for an annual address before a gathering of agriculturists will be a comprehensive and critical review of the more outstanding items of research and demonstration carried on during the past year in the realm of agriculture all over the world. I have, however, no hesitation to admit that I have not been able to undertake such a task; nor is it an easy job to pitch upon a subject which might interest everyone of us equally, made up as we are of members engaged in numerous special lines of research in this many-sided subject of Agriculture. I have therefore selected a theme which will certainly conform to one of our implied conventions that it should be one connected with some aspect of agriculture; but beyond that qualification I am not quite sure whether my choice will be found quite appropriate or satisfactory. In looking over the subjects treated by some of my predecessors in this chair, I find that a good many phases of Indian agriculture have been ably and exhaustively dealt with. I however feel, though perhaps with some natural bias, that the subject of the rôle of insects in relation to Indian Agriculture has not till now received as much attention as is consistent with its importance in agricultural practices all over the world. Though some of the past presidents have made passing references to insect pests in their addresses I am not quite sure whether any of them has dealt with this subject as a special theme. I am therefore attempting in this brief address to present some of the salient features relating to insects with a brief survey of some of the many insect problems connected with Indian agriculture and to offer a few remarks and suggestions of my own.

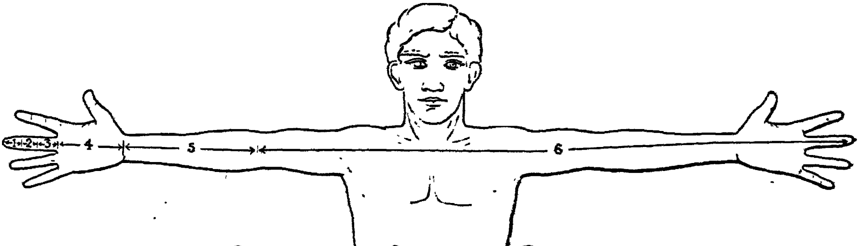
ANIMALS AND MAN.

The Indian farmer has to solve many important problems if he ventures to succeed in raising a good crop with advantage; these include among others matters relating to the physical and chemical characters of the soil, the health and reliability of the seeds, the satisfactory nature and vigorous growth of the plants, and in addition to all such aspects, is the problem of the protection of these crops from their various animal foes. For, in spite of the best cultural attentions of the agriculturist, the finest manuring by the chemist or the most up-to-date methods of the botanist to raise a healthy and heavy yielding crop, it is within the power of some animal enemies of crops to undo all such laudable efforts by making one clean sweep of all the growing plants in any area, even within the period of a few hours! A prudent farmer will therefore do well to get himself equipped with some general ideas regarding the bionomics of at least some of the more important of these animal pests, some of which levy a heavy toll on his crops season after season, so that he may be able to reduce at least some part of the havoc so caused. The existence of animals injurious and friendly to man is a fact very well realized even among laymen; for, from the very early days when half-civilized man gave up his hunting and predatory habits for a settled life and began to grow crops and tend cattle, the various forms of life associated with these early activities also became his lifelong companions for weal or woe. Gradually, during ages of civilization, as man began to clear wild jungle and grow crops in large areas for his food, clothing and other material needs, his relations with different forms of life became more and more pronounced and animals of different kinds began to interfere with his activities both for good and harm. Under the category of these animal associates we have groups of various animals from the mighty elephant to the minutest mite.

Economic Zoology:—The study of the relations of animals with man and the utilization of such knowledge to promote human welfare has been engaging the attention of biologists in recent years and this branch of zoological study goes by the name of Economic Zoology. It must be stated, however, that until about the middle of the last century zoological studies were pursued more with the idea of discovering and elucidating scientific facts than with the object of utilizing the knowledge so gained towards the every-day needs and practical affairs of humanity—in other words, very little attention was paid to Economic Zoology as compared with the purely academical aspects of the science of Zoology. But the rapid march of civilization, the general increase in the earth's population, the growing rivalry among the most advanced nations in the exploitation of the rich tropical regions, the frequent wars in that connection and the consequent economic needs of human communities all over the world—all these have compelled man to look for the applied aspects of the different sciences for his future needs. The remarks of Wilson, the late chief of the U.S.A. Biological Survey, beautifully sum up the great importance of this subject in the economy of man: 'In its relation to public welfare Economic Zoology is of the most vital and far-reaching importance. Animal life from its lowest organisms, among which lurk some of our deadliest foes as well as beneficent friends, to the highest vertebrates, touches and affects our lives and welfare in innumerable ways. It must be studied in all its phases as never before to guard against previously unsuspected or little known diseases of man and domestic animals as well as to develop the wealth and ever-increasing variety of products from which we obtain food, medicines, clothing, dyes, ornaments and an endless number of useful articles. No man can be considered well-informed who has not a considerable knowledge of Economic Zoology in its more direct relationship to human life, while to the scientific investigator the subject has the charm of endless variety and service to mankind'. One important branch of Economic Zoology is that known as Agricultural Zoology which includes the study of all animals which interfere with the various interests of the farmer; and of all such forms of life which have anything to do with the agriculturist, the miller, the grocer or the stock breeder, no single group of animals plays such a prominent rôle in a variety of ways as insects. While the study of insects in all their various aspects is known as Entomology that branch of it which deals with their activities in relation to Agriculture is known as Agricultural Entomology.

INSECTS: STATUS AMONG ANIMALS AND THEIR STRIKING FEATURES.

I may be excused when I say that until about a decade or so ago very few zoologists, at any rate in India, had any definite ideas regarding the comparative status and importance of insects among the various groups of animals. During the early days of my official career, *viz.*, during the early years of this century, I had opportunities of coming across many a Zoology graduate who knew very little of insects and was even a stranger to the word *Entomology* (the science of insects). Of course, such a state of affairs then is no wonder, since even now we come across prominent zoologists speaking on Zoology almost ignoring this group and its importance, apparently not realizing the conspicuous status of insects among animals not only as a group possessing remarkable features of scientific interest, but also as one possessing very great economic importance. Among the various living beings inhabiting this world, no other group of animals, except perhaps the fishes, can approach the insect community either in numerical strength or in the wealth and variety of species. The number of known living species of animals has been roughly estimated at about 900,000 and of this number over 60% or about 625,000 are found to be insects. To give an easily comprehensive idea of the comparative size of this group among the various divisions of the animal kingdom we may take this illustration: If we take the entire distance between the finger tips of our outstretched right and left arms across our chest to represent the size of the whole animal kingdom, then the size of all the other groups put together will not extend beyond the elbow of one arm from its finger tip, whereas the size of the insect group would occupy a distance stretching from the elbow of one arm across the chest and the two shoulders right up to the tip of the middle finger of the other arm (see fig.).



SIZE OF ANIMAL GROUPS

1 Mammals
2 Reptiles
3 Birds
4 Fishes
5 All others besides insects
6 Insects

Striking features of Insects:—Hardly any naturalist who knows anything of insects and their ways will doubt the fact that, in the keen struggle for existence going on incessantly in nature among the various forms of life no other animals have gained such remarkable success as the members of the insect world. This may be attributed among others to such important factors as their remarkable numerical strength, their peculiar life histories, their extraordinary powers of multiplication and their wonderful adaptations to put up a strong fight and survive in the general struggle for life. Though insects are comparatively much smaller in size than many other familiar animals—the size varying from $\frac{1}{100}$th of an inch in the case of the minutest forms to only about 6 or 7 inches in the case of the biggest insects, this apparent defect is more than made up by their remarkable numerical strength as has been shown above. As regards the distribution of insects, it may be stated that they are found all over the world; in land and water, on trees and shrubs, on other animals and man, in households and under the soil. Knipe has described the creatures in the following lines:—

'And what of insects, present everywhere,
Through sea and land and flitting in the air?
Why, half the matter charged with light on land
These little creatures, countless, must command;
See how in orders, legions filled, they rise,
Living alone, and in communities;
From mites so small as scarce to meet the eye,
To ant and bee, and gorgeous butterfly.'

To give even a very vague idea of the remarkable adaptations possessed by insects to carry on successfully their vital activities will occupy pages of matter; so numerous, varied and extraordinary are these. Astonishing are the various adaptations for securing food, the structural provisions for offence and defence, the wonderful arrangements for communication between each other and the innumerable adjustments for sexual relations and propagation of the species. Such wonderful phenomena as parasitism and social life, the various adaptations in structure, mimicry, maternal instinct, and a host of other features in their life activities which Thompson aptly calls 'shifts for a living', are factors very remarkable and often unique in the world of insects. As Riley has said, 'If we could put the directing inquiry of the human brain in a body like that of the insects with a hard external shell, at once a defence against external attack and a protection to delicate vital organs, yet allowing free play for every desirable movement; with a breathing system that is diverse and multiple and therefore less liable to get out of order than ours; with six hands and feet instead of four; with a powerful venomous sting for defence; with the power of flight independent of unreliable machinery; with the enormous industry of an organization in which each caste or profession is determined at birth and where there are apparently no labour strikes, legislative filibusters or revolutions, but the greatest of self-sacrifice and loyalty to the common weal; with a reproductive system capable of producing young at the rate of one per second almost indefinitely yet provided with efficient birth control when needed; in such a picture we have a creature for which man would be but a poor competitor'.

One of the most remarkable phenomena in the whole animal kingdom is the peculiarity found in the life histories of many insects. Unlike the case of higher animals and many other lower animals there is found a phenomenon known as 'Metamorphosis' among insects, a series of striking and remarkable changes undergone by the creature as it passes from its childhood to its adult stage. The passage of a common butterfly from the tiny egg to the worm-like caterpillar, thence into an apparently lifeless object the chrysalis or pupa, and the final transformation into the beautiful winged butterfly—all these striking changes, known together as Metamorphosis, constitute a phenomenon which even many of our educated men are not aware of, though Shakespeare put it so beautifully in the lines:—

'There is a difference between a grub and a butterfly
Yet your butterfly was a grub.'

Most insects give rise to numerous offspring which in their turn produce further generations in a very short period of time compared to higher animals and thus increase in numbers rapidly. These two advantages of greater fecundity and shorter life cycle play a very important part in maintaining the remarkable numerical strength of many insects. According to Hodge 'a pair of flies beginning operations in April might be progenitors, if all were to live, of 191,010,000,000,000,000,000 flies by August, and allowing ⅛ cubic inch to a fly, this number would cover the earth 47 feet deep!' It is very likely that the famous naturalist Linneaus had in view some idea of these extraordinary powers of multiplication in these lower animals when he made the paradoxical remark that 'three flies consume the carcase of a horse as quickly as a lion'.

INSECTS AND HUMAN INTERESTS.

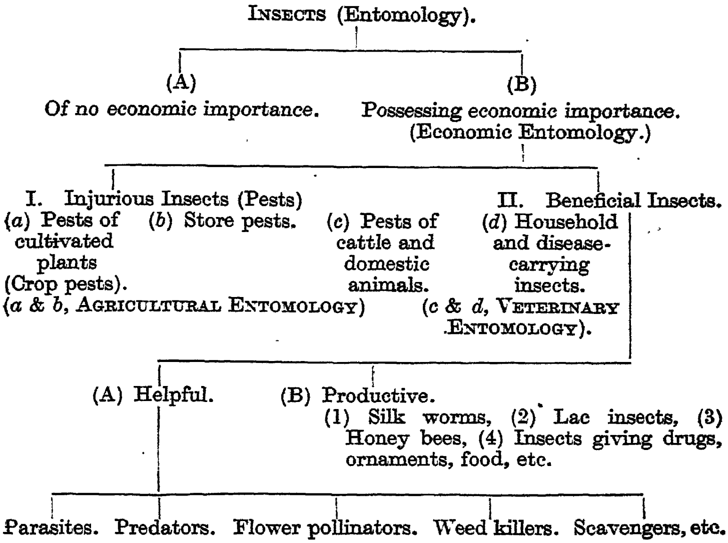
With these necessarily brief remarks on the general features of insects and their comparative importance I would just refer you to some of the various aspects in which insects affect human welfare. Speaking of the relations existing between man and insects it might be safely stated that no group of animals has so far approached these creatures in their intimate relations with man and his belongings either in diversity or in magnitude. It is common knowledge that insects affect human interests both for good and evil, though their injurious proclivities are far better known to us than the beneficial aspects of their activities. Nor can we conclude that all insects as a group have something or other to do with man, since there are a good many forms which do not directly affect human interests either for good or evil. Based chiefly on their morphological features the class insects as a whole is divided by zoologists into nine major divisions called orders although recent workers have split up these nine into two dozen orders. The names and the comparative strength and size of each of these subdivisions may be made out from the following tabular arrangement:—

The comparative size and known strength of each of the important insect orders.

COLEOPTERA (Beetles)	250,000 known forms.
LEPIDOPTERA (Moths and Butterflies)	120,000 ,, ,,
HYMENOPTERA (Ants, Bees, Wasps)	86,000 ,, ,,
DIPTERA (Flies)	75,000 ,, ,,
RHYNCHOTA (Bugs)	55,000 ,, ,,
ORTHOPTERA (Grasshoppers, Crickets, etc.)	19,000 ,, ,,
NEUROPTERA (Dragon flies, White ants, etc.)	16,000 ,, ,,
APTERA (Silver fish, etc.)	1,500 ,, ,,
THYSANOPTERA (Thrips)	700 ,, ,,

Approximate number of known insects about 625,000 species.

Popular classification :—But from the point of view of the economic character of these animals we can easily classify all insects into three convenient groups, *viz.* Harmless, Injurious, and Beneficial forms. For the present we can leave out of consideration the first group which, though including thousands of forms, is not at present found to affect the economy of man. It must, however, be noted that there are no hard and fast rules in nature which prevent any insect from changing its existing habits and thereafter affecting human interests. It is quite possible that altered conditions might now and then turn a harmless insect into an injurious form and *vice versa*, as is occasionally experienced in different countries. Coming to the other two groups which include the really economic forms, we can break them up into special categories according to the nature of the good or evil the different forms are capable of producing in the economy of man. The following arrangement may be found explanatory of this popular classification of insects:—



INSECTS (Entomology).

(A) *Of no economic importance.*

(B) Possessing economic importance. (Economic Entomology.)

I. Injurious Insects (Pests)

- (*a*) Pests of cultivated plants (Crop pests).
- (*b*) Store pests.
- (*c*) Pests of cattle and domestic animals.
- (*d*) Household and disease-carrying insects.

(*a* & *b*, AGRICULTURAL ENTOMOLOGY) (*c* & *d*, VETERINARY ENTOMOLOGY).

II. Beneficial Insects.

(A) Helpful.

(B) Productive.
(1) Silk worms, (2) Lac insects, (3) Honey bees, (4) Insects giving drugs, ornaments, food, etc.

Parasites. Predators. Flower pollinators. Weed killers. Scavengers, etc.

Beneficial and Injurious Insects :—Being familiar only with the injuries caused by insects which are commoner and more evident, our farmers often doubt whether there can be any good insects at all!! Most of them do not have any proper idea of the good services rendered by many insects. It is therefore desirable that every agriculturist should realize that among insects there are several forms which are beneficial to him and try to recognize the good from the bad and not condemn them all alike. 'The first step towards vanquishing an enemy', in the words of Curtis, 'is to ascertain correctly its habits, the next is to be certain of its appearance as not to mistake one party for another, and a third and no less important object is to be well acquainted with our friends and allies.'

From the above table it may be clearly found that beneficial insects help man in different ways in the same manner as injurious ones cause him damage and loss. Though it has to be admitted that there are numerous insects which are beneficial to man in different ways, as far as we know, the number of injurious forms and the extent of damage caused by them appear to be far greater than the gains caused by good insects.

EXTENT OF DAMAGE AND LOSS CAUSED BY NOXIOUS INSECTS.

Any insect, or for the matter of that any animal or plant which becomes a source of trouble or material loss is considered a pest, and among insects such pests are numerous and include different categories as may be seen from the above grouping.

When the damage done and the loss caused thereby by any single pest is substantial, that one is reckoned as a major pest and when the injury inflicted by any form is slight and not worth noticing it is classed as a minor pest. There are others, the activities of which are erratic which are regarded as occasional or sporadic minor pests according to the damage and frequency of their appearances. Confining ourselves to the consideration of the part played by insects in relation to Indian agriculture, we naturally ask what the nature and extent of this relation are. The answer to this query is effectively supplied by the farmer, the grocer, the miller or the stock breeder, who are better aware of the periodical losses caused by noxious insects to their cultivated or stored products than the man in the street or the platform politician. To the average farmer it is only the occasional flights of locusts or plagues of active caterpillars or bugs which appear to be striking, while he is blind to many other forms which silently but steadily levy a heavy toll on his agricultural products year after year. During certain unfavourable seasons cultivated crops in extensive areas are seriously damaged and in some cases entirely wiped out by some insect pests and wholesale loss caused to the farmer; such occasional losses almost set calculation at defiance! According to Curtis 'if an approximation could be made to the quantity thus destroyed the world would remain sceptical of the results obtained, considering it to be too marvellous to be received as truth'. Though in our country we have not as yet accumulated any accurate or sufficient data or statistics as to the extent of losses caused by noxious insects, such statistics are now-a-days maintained by some countries advanced in scientific agriculture, especially by the U.S. of America. According to Webster 'it costs the American farmer more to feed his insect foes than it does to educate his children; the estimated damage done by insects comes annually to 400 million dollars, while the common schools and higher educational institutions cost together only 300 million dollars'. In the words of Slingerland, 'The yearly losses from insect ravages in the U.S.A. aggregate nearly twice as much as it costs to maintain our army and navy, more than twice the loss by fire, twice the capital invested in manufacturing agricultural implements and nearly three times the estimated value of the products of all the fruit-orchards, vineyards and small fruit-farms in the country'. These statements were made over twenty or thirty years ago. From recent and more accurate data compiled by the Insect Pest Survey of the U.S.A. Department of Agriculture, we find that the total estimated loss due to insects attacking staple crops, vegetables, fruits, nursery and greenhouse products, stored products, live stock, etc., comes to over a thousand million dollars (a dollar being roughly equivalent to Rs.3), *viz.* 1,426,164,000 dollars. This does not, however, include the loss caused by insect-borne diseases or forest pests, both of which together have been estimated to cause a further loss of 180 million dollars. It is interesting to note that these statistics also give the credit side of the picture with rough estimates of the annual gains from insect agency, such as production of Silk, Honey, Beeswax, Shellac, Drugs, etc., and this is put down at 454 million dollars. Adjusting the credit and debit sides we find that agricultural products alone suffer a loss of nearly a thousand million dollars every year in the U.S.A. The U.S.A. Board of Entomology estimates the annual loss from one pest, the cotton boll weevil alone, at 200,000,000 dollars. While these figures are staggering to the layman they are unfortunately true, and if they are not quite accurate they only suffer from the defect of under-estimation. Coming to the state of affairs in India though statistics of the nature described above are not available, the seriousness of the matter has, now-a-days, begun to be recognized. I would invite the attention of those interested in the matter to the excellent address of Afzal Hussain as President of the temporarily opened section of Entomology during last year's Congress at Calcutta. In speaking of the importance of the science of Entomology he has also drawn attention to the opinions of different men *re* losses caused in India by insects to important crops like wheat, sugarcane, cotton, etc. In the following table I have just attempted to give some general ideas regarding the loss caused by insect pests to a few of our more important crops, basing my calculations on the crop estimates from recent Government reports and agricultural statistics:—

CROP.	AREA.	YIELD.	ESTIMATED VALUE.
1. Rice ..	82 milln. Acres.	30 milln. Tons.	Rs.2,835 milln.
2. Wheat ..	35 ,, ,,	9 ,, ,,	,, 851 ,,
3. Cotton ..	25 ,, ,,	6 ,, ,,	,, 600 ,,
4. Sugarcane ..	4 ,, ,,	5 ,, ,,	,, 450 ,,
5. Oil-seeds ..	22 ,, ,,	3 ,, ,,	,, 250 ,,

Total estimated value—Rs.4,986 milln.

From these data the total estimated value of the products actually got, deducting the toll taken by insects, comes to 4,986 millions of rupees and taking 4% of the crop yield for this toll, the latter comes to an amount of over 200 million rupees. In these estimates I have, as is evident, taken only a few crops into consideration and have calculated the percentage of loss only at 4% and not at 10% as is generally done. Nor have I taken into consideration the wholesale losses, often caused to some of our crops during certain bad years by flights of locusts and plagues of caterpillars, bugs or beetles; and yet the loss in connection with just half a dozen of our crops comes to a substantial amount. Noel Paton,[1] formerly Director of Commercial

Intelligence in India, estimated over twenty-five years ago the annual loss caused to paddy and stored rice by the small rice weevil (*Calandra oryzae*) at over 120 millions of rupees. Thus it is evident that a good bulk of the Indian farmers' produce goes to feed insects year after year.

PEST OUTBREAKS AND FACTORS INFLUENCING THEM.

Looking at the various local beliefs entertained by villagers as to the causes that bring about insect outbreaks, we can find, unfortunately, very little of any scientific tinge in them. The chief of these are God's curse, the alleged bad position of the planets for the season according to the prediction of a local oracle or astrologer, the displeasure of a particular village deity who was not properly propitiated, a neighbour's black art or evil eye, the approach of a polluted man or woman, a bad wind, floods, sudden and unexpected changes in the weather and a number of other causes real and supernatural. It need hardly be stated that with the exception of a few of these which are quite evident, none of these factors would generally appeal to the scientific man and could therefore be brought within the realm of practical politics. However, one or two interesting points with regard to some of the prevailing local beliefs on the origin or increase of crop pests may be mentioned here. The appearance or disappearance of insect pests is very often closely associated in different parts of South India with the appearance and the direction of the winds; this is especially the case in the delta tracts of the Godavari and Kistna districts in South India—the *payirgali* and the *thoorpugali* have their own significance and are regarded as very important by the Telugu farmers. A good deal of stress is also laid on the time of sowing particular crops to avoid pests, and I have heard from experienced and educated ryots that in some cases early sown fields, and in others late sown ones, suffer from pests. Such beliefs are entertained in many places and are probably the conclusions of years of experience, and as such we are not yet in a position to belittle them, though very convincing scientific explanations for many such phenomena have yet to be worked out.

Balance of Life :—There is a general belief that insect pests, especially crop pests, appear more frequently now-a-days than in the past and many an old farmer has asserted to me that during the palmy early years of his life they had very few and only occasional outbreaks of pests to contend with. We have to admit the truth of this statement to a very great extent. Under normal conditions in the living world, the lives of plants and animals are so wonderfully adjusted that the extraordinary increase or multiplication of any one species to the detriment of

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[1] Bulletin on Burma Rice, 1912.

another is held in check, and what is known as the 'Balance of life' is kept up in nature. It is believed that the more important factors, which play their part in maintaining such a normal balance of life in nature are dearth of food, climate and enemies. Many forms of life, especially lower animals, die of starvation and if they happen to depend on particular plants for their food, the absence of this latter during certain seasons checks their growth and multiplication; in the same manner extremes of climate also act as important checks to multiplication of various animals and plants. The presence of various predatory animals which depend for their food on other forms of life also contributes a substantial share in checking the multiplication of numerous smaller organisms. To these carnivorous enemies may be added the diseases and maladies of a fungoid or bacterial nature which levy their toll on organisms of various kinds. It is only when one or more of these important natural checking factors are prevented from playing their parts freely that the normal equilibrium in nature is upset and opportunities offer themselves for the abnormal increase in some forms of life which consequently become pests.

Factors disturbing the Balance:—One of the most potent causes which helps to upset this balance is the part played by human agency. For, as civilization advanced and man, 'Nature's insurgent son' as Lankester calls him, began to conquer and control nature in various ways, numerous changes have been brought about in the life conditions of almost all organisms in the world, and especially has it been so among the lower forms like insects, etc., and such changes account for the occasional multiplication of certain forms of life in abnormal proportions and assuming the status of pests. Some of the more important human influences which help to upset the even level of insects in nature are the growing of single crops in extensive areas, the destruction of insect enemies such as birds, reptiles, frogs, etc., and the frequent and thoughtless transport of various forms of desirable and undesirable plants and animals from one country to another. These causes, which now take place almost daily, must to a greater extent account for the frequent appearance of pests in these days. When we briefly examine these important factors, we find that the growing of single crops in the same locality in extensive areas helps any insect feeding on such plants to increase and multiply; for, as against the old days when such insects had to search out their food plant in the jungles and in that attempt risk several dangers and climatic influences, in a modern cultivated field a rice or cotton insect is able to get plenty of food in the same field and thereby escape the operation of some of the checks mentioned above, *viz.* food, enemies or climate. The destruction of forest areas now-a-days for various purposes, besides upsetting the physiographical and meteorological conditions of any area, has gradually driven several insects originally living on forest vegetation to transfer their activities to economic plants and thereby become pests. The reckless destruction of animals like insectivorous birds, reptiles and mammals and the conscious or unconscious extermination of numerous insects feeding on insects (*Entomophagous*) effectively interfere with the functions of many creatures which act as natural checks over several pests. The frequent transport of plants and animals from one country to another, without in the least realizing or foreseeing the disadvantages, has often caused disastrous results in some cases. The introduction of the rabbit into Australia and the mungoose into the West Indies and the consequent realization of these two as blunders are classical examples in that direction. Similarly there are many good examples of how man's activities have altered an environment so as to render it unsuitable for plant species and thus produce conditions highly favourable for the building up of an insect pest population. The four factors noted above are, as far as we know, the most important agencies frequently upsetting the natural balance of life and helping various organisms to multiply abnormally and interfere with human interests. But in any case of pest outbreaks it may be often very difficult to point out exactly which one of these various factors is responsible for the same, for, in most cases, it may be due to one of these or a combination of one or more of these factors.

NATURE AND RANGE OF INSECT INJURY AND INCIDENCE.

There is hardly any cultivated plant which escapes the attentions of some insect or other though it may be found that some plants are more susceptible to their attacks than others. It is also found that among plant-feeding insects, while a few of them depend for their food almost entirely on one plant (*Monophagous*), there are many others which are not so fastidious as regards their food and are found feeding on more than one food material (*Polyphagous*). As to the nature of the damage caused to plants, it will also be found that no part of a plant is immune to insect attack and that every portion of it has its peculiar insect associates; the roots, stem, bark, shoots, leaves, flowers and fruits have all their characteristic insect enemies; nor is it rare to find insects of sorts visiting or temporarily remaining on plants either as mere visitors or minor pests. Under these circumstances, it will be very advantageous if every cultivator gets to know in the first place which insects are his enemies and which are not, and of the former he might note those which constitute the major or important pests and those which are of minor importance. This can be done by correct observation in the fields by the simple 'art of seeing which is so useful, so universal and yet so uncommon'! These are essential pre-requisites before one attempts to devise the possible control measures suited to each of them as necessities arise.

Symptoms of Insect Damage:—Generally every insect feeding on a plant has some peculiar habit of attack and manner of feeding which cause the infected plant to exhibit some characteristic condition or symptom by which the insect causing it may be determined more or less correctly. The multifarious forms of injury caused by insects to plants can all be attributed to two fundamental methods of attack. (1) Damage caused by mastication and chewing of the food material which is generally of a solid nature, familiar examples of insects causing such damage being grasshoppers, beetles, and caterpillars of sorts. (2) Damage inflicted by the sucking up of the juice from the infested material, this evidently taking liquid food; well-known insects causing injury in this way are the many plant bugs, mosquitoes and flies. Those of the former category are known as mandibulate or chewing insects and the latter as suctorial forms. In the former case the infested material generally exhibits damages such as torn leaves, open fruits, hollowed out buds, stems, etc.; whereas in the injury inflicted by a sucking insect the external manifestations generally consist in the gradual fading up of the plant or the shrinking up of the sucked up material without any change in the general form or shape of the plant, though the plant suffers considerably by drainage of sap.

Insect Categories:—It might be pointed out that, apart from specific insects attacking particular crops all over India, there are a few well-known categories of insects which though infesting many crops cause the same kind of damage, and as such may be found amenable to the same control methods. Practically many important pests of crops can be brought under one or other of these familiar categories. The most important ones among these are Grasshoppers, Caterpillars, and active Plant bugs, Plant lice, Thrips, Scales and mealy bugs, Beetles, and borers of sorts (chiefly caterpillars, grubs and maggots). Included under each of these groups we come across forms showing different habits regarding the choice of their host plants, method of attack and times of appearance; as for instance, among grasshoppers we have locusts, field grasshoppers, and surface grasshoppers with their special propensities and periods of incidence! Among caterpillars are found numerous varieties such as hairy caterpillars, cut worms, leaf folders, miners, swarming caterpillars, etc.; bugs include stink bugs, mosquito bugs, leaf hoppers, plant lice, etc.; beetles include numerous forms like chafers, weevils, flea beetles, longicorn beetles, click beetles, etc., etc., and under borers, which form a very important group of pests inflicting serious injury, we find larval forms, representatives chiefly of the groups moths, beetles and flies. The following table might give some general ideas regarding the different varieties of insects usually found affecting the various parts of of growing plants during the different stages of their respective growth:—

Different parts of plants. (1)	Chief categories of insects. (2)	Some South Indian examples. (3)
Sown seeds and roots underground.	White grubs, crickets, termites. root bugs, root beetles, wire worms and ants.	Rose and other chafer grubs, mole-cricket, sugarcane and grape termites, tobacco root bug, the ragi root aphis, potato and tobacco root beetles, aphid-carrying ants, wooly blight of apple, etc.
Young plants above ground surface.	Cut worms, surface grasshoppers, and beetles, flea beetles, ants, crickets.	Cut worms on various crops like patato, paddy and tobacco, the brown ground grasshoppers (*Chrotogonous*) on various cereals and other dry and garden crops, the surface weevil of cotton, small red ant nibbling brinjal seedlings, and plant lice on various garden seedlings.
Bark and stem ..	Bark caterpillars, bark grasshoppers, bark bugs, stem-boring caterpillars and grubs, stem maggots, stem girdlers, scale insects, termites.	Bark borers of avenue trees and fruit trees, the mango stem borers, the borers in stems of paddy, millet, agathi, etc., cotton stem weevil, the grape vine girdler, cowpea stem fly, silver shootsfly, the red palm weevil, sweet potato weevil, the nim scale, cane mealy bug, the rubber bark beetles.
Shoots, leaves and flowers.	Grasshoppers, leaf cutter bees, beetles of various kinds (chafers, tortoise beetles, weevils, leaf miner beetles), caterpillars of numerous categories (hairy, spiny, smooth sluggish, leaf folding, leaf mining, shoot and leaf webbing, bag building), sawfly grubs, gall	The rice grasshopper, the Deccan grasshopper, the rose leaf cutter bees (*Megachile*), rhinoceros beetles, the chafers on grape leaf, pumpkin beetles, rice hispa, flea beetles on grapes, radish, millets, sunnhemp, etc., blister beetles on millets, etc., caterpillars on various crops, red hairy caterpillar, Lab lab sphinx, cotton leaf roller,

Different parts of plants. (1)	Chief categories of insects. (2)	Some South Indian examples. (3)
	fly maggots, leaf and shoot bugs of different habits (stink bugs, hopper bugs, spittle bugs, plant lice, scales, and mealy bugs, mealy wings, Psyllidæ (Jumping lice), mosquito bugs, (Capsidæ) lace bugs, etc., thrips, blister beetles.	mustard sawfly, mango hopper, betelvine bug, grape, chillies and onion thrips, coffee green scale, cane mealy wing, cane leaf hopper, cotton aphis, brinjal lace-wing bug, etc.
Fruits, earheads, seed pods.	Fruit pod and earhead caterpillars, fruit moths, sucking bugs, fruit flies, earhead and pod bugs, pod flies, earhead bugs.	Mango and other fruit flies, bollworms of cotton, citrus fruit sucking moths and bugs, red gram pod fly, tobacco seed capsule and tomato borer, pulse bruchids, pepper pollu flea beetle, the pomegranate butterfly, potato borer, castor seed borer, brinjal fruit borer, etc.

Virus Diseases :—Speaking of the different types of injuries caused to plants by insects I may just make mention of the part attributed to certain insects as vectors of plant maladies known as virus diseases, where no insect or fungus is caught red-handed. A 'Virus', according to Smith, is an agent below or just on the border line of microscopic visibility that causes disturbances in the functions of living cells (of plants) and causes malformations and damage to them. It has also been discovered recently that certain insects like some plant lice, thrips, etc., act as vectors of these infectious diseases. Such diseases have been noted so far on plants like Tobacco, Sugarcane, Sorghum, Brinjal, etc. Very little however is known of these virus diseases in India and especially the rôle of insects as vectors; the field is therefore almost unexplored in India and offers a virgin ground both for entomologists and mycologists.

Thus by gradual experience in noting the different symptoms of damage caused to his crops by diverse insects the farmer will be in a position to make out more or less correctly, even from the external indications of the damage done, the particular kind of insect concerned in each attack; nor will he find it difficult in course of time to foresee as to the season or seasons when he might expect particular pests of different crops. In this way experienced farmers of each agricultural tract may be in a position to prepare what may be called 'Insect pest calendars' to each area and thus, be not only well prepared to meet insect pests when they appear, but even be fit to prevent their appearance by methods adopted sufficiently early. References may be made to a few such calendars[1] which I have attempted to prepare for South India (see figure on p. 289). In the same way, cultivators of special crops also come to learn by experience as to the particular stage or stages in the growth of these crops when under normal conditions they can expect any kind of pest in their areas. The diagram on p. 290 gives an example of one made in connection with rice crop in South India.

To the Indian farmer who is anxious to reduce the annual toll levied by insects on his crops such items of information regarding noted pests will be a very valuable asset in helping him as guides to warn him to be on the guard and be prepared to meet an outbreak and prevent it or nip it in the bud. In spite of all the inevitable defects such calendars are bound to possess, it is hoped they might serve some useful purpose as rough guides.

SOME INSECT PROBLEMS CONNECTED WITH AGRICULTURE IN INDIA.

The studies carried out in different parts of India on insects of economic importance for over three decades in the past have indicated that there exist in India not less than four to five hundred insect forms which have been found associated with the numerous cultivated plants of the different provinces, causing injury to a smaller or greater degree. As far as I am aware the first list of insects associated with Indian crops was published by Cotes[2] in 1832. In this paper both injurious and beneficial forms were included and unfortunately many of the species are not properly identified. The next list was issued by Lefroy in 1907[3] and this gives a fairly good idea of the more important crop pests of the plains of India and includes 130 forms. A supplementary list was issued by the same worker in 1911[4] for departmental use and in this list the number of insects had increased to 197. In 1919[5] again Fletcher's list of Indian crop pests appeared—a comprehensive list including over five hundred forms, a good many of which, however, being of minor importance. For the S. Indian region alone in a list of pests I prepared in 1932[6]

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[1] Entomologist's Crop Pest Calendars for the Madras Presidency. Madras Agr. Deptl. Bull. No. 80 (1921).

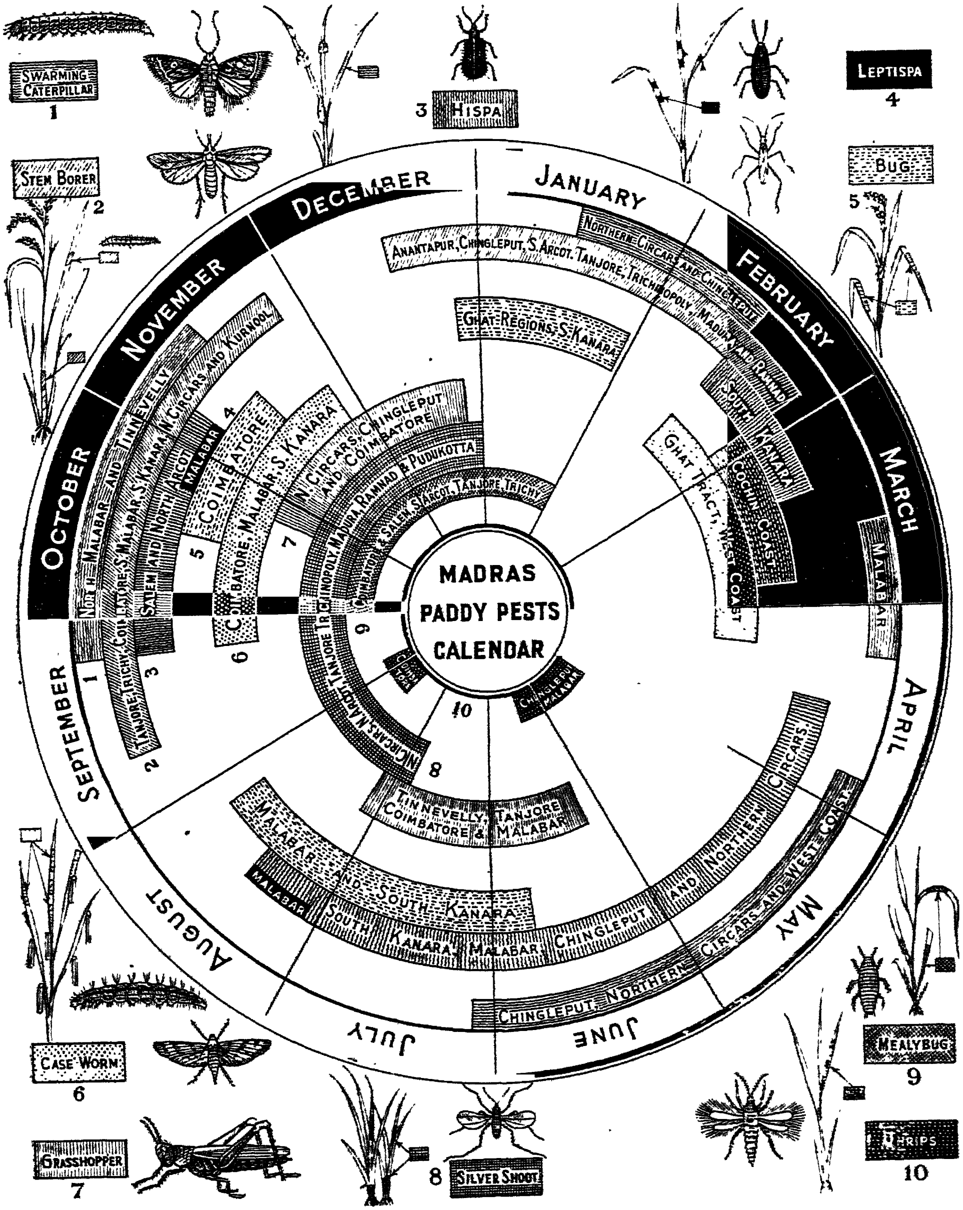
[2] Indian Museum Notes, 1832, Vol. 11, Calcutta, pp. 145–176.

[3] Lefroy—Memoirs of the Dept. of Agr. Ent. Ser. 1(*a*).

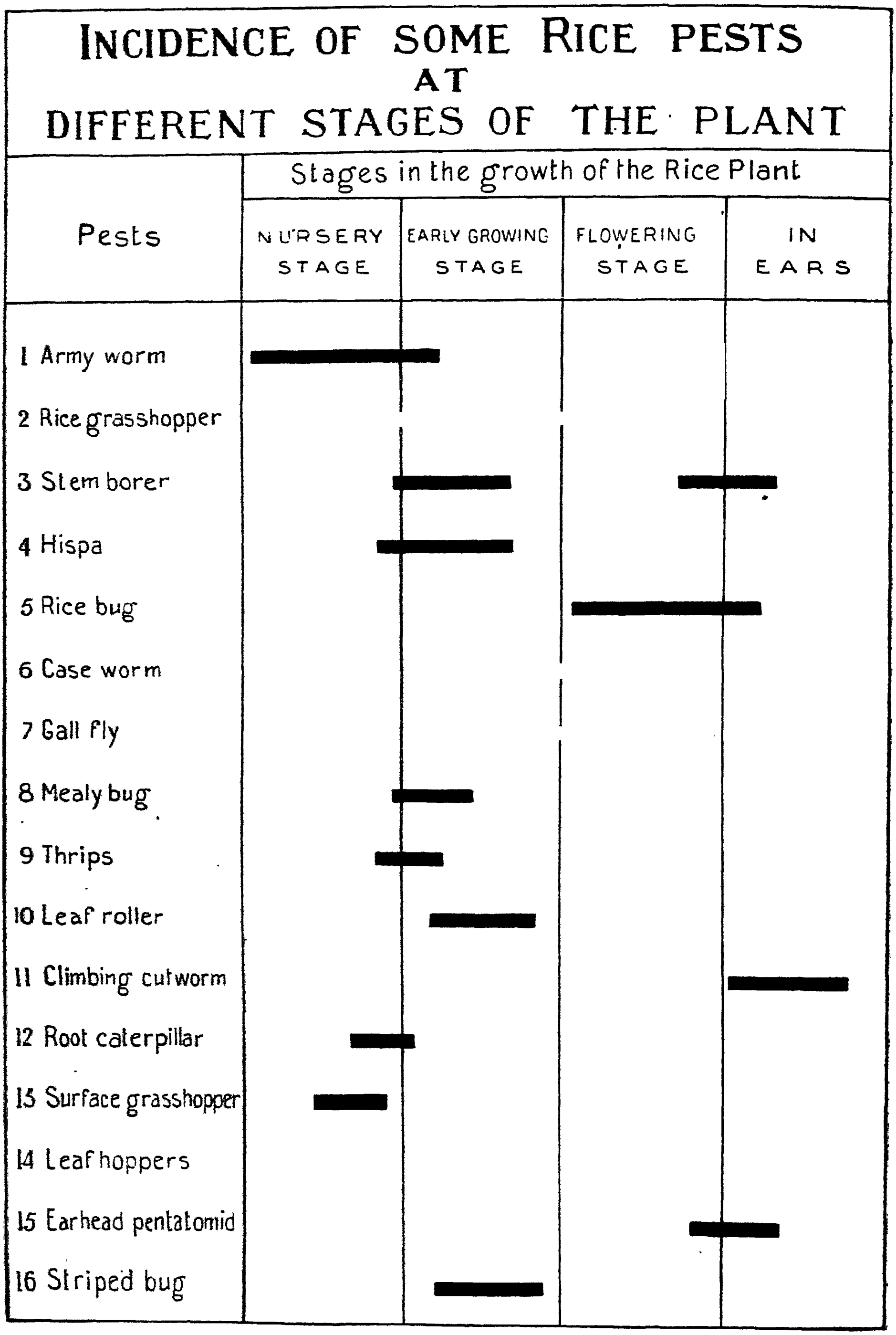
[4] Lefroy—List of injurious insects of India, Pusa.

[5] Fletcher, 1919, Rept. of 3rd Ent. Meeting.

[6] 1932, Bulletin 27 of Madras Agr. Dept.


SWARMING CATERPILLAR
1
STEM BORER
2
3 HISPA
LEPTISPA
4
BUG
5
CASE WORM
6
GRASSHOPPER
7
8 SILVER SHOOT
MEALYBUG
9
THRIPS
10
MADRAS
PADDY PESTS
CALENDAR
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
NORTHERN CIRCARS AND CHINGLEPUT
ANANTAPUR, CHINGLEPUT, S. ARCOT. TANJORE, TRICHINOPOLY, MADURA AND RAMNAD
GHAT-REGIONS, S. KANARA
SOUTH KANARA
COCHIN COAST
GHAT TRACT, WEST COAST
MALABAR
NORTH MALABAR AND TINNEVELLY
COIMBATORE, S. MALABAR, S. KANARA, N. CIRCARS AND KURNOOL
TANJORE, TRICHY, COIMBATORE
SALEM AND NORTH ARCOT
MALABAR
COIMBATORE
COIMBATORE, MALABAR, S. KANARA
COIMBATORE
N. CIRCARS, CHINGLEPUT AND COIMBATORE
TRICHINOPOLY, MADURA, RAMNAD & PUDUKOTTA
COIMBATORE & SALEM, S. ARCOT, TANJORE, TRICHY
N. CIRCARS, N. ARCOT, TANJORE TR
CHINGLEPUT MALABAR
TINNEVELLY, TANJORE COIMBATORE & MALABAR
MALABAR AND SOUTH KANARA
MALABAR
SOUTH KANARA, MALABAR, CHINGLEPUT AND NORTHERN CIRCARS
CHINGLEPUT, NORTHERN CIRCARS AND WEST COAST
1
2
3
4
5
6
7
8
9
10

MADRAS PADDY PESTS CALENDAR.


INCIDENCE OF SOME RICE PESTS AT DIFFERENT STAGES OF THE PLANT
Pests
Stages in the growth of the Rice Plant
NURSERY STAGE
EARLY GROWING STAGE
FLOWERING STAGE
IN EARS
1 Army worm
2 Rice grasshopper
3 Stem borer
4 Hispa
5 Rice bug
6 Case worm
7 Gall fly
8 Mealy bug
9 Thrips
10 Leaf roller
11 Climbing cutworm
12 Root caterpillar
13 Surface grasshopper
14 Leaf hoppers
15 Earhead pentatomid
16 Striped bug

I have made 535 entries in association with 125 plants grown in S. India and of these I have marked about 210 forms as fairly worthy of notice. It is quite possible that further researches in the future might discover hitherto unnoticed species of insects affecting Indian crops and supplement the lists so far made. While there is no doubt that these lists are helpful to us in conveying some general ideas of the various insects associated with different plants and some indications as to their future potentialities, only a few of these numerous forms can be reckoned as really serious pests and deserving of special attention. All these preliminary surveys have, however, enabled us to a considerable degree to get some very definite ideas regarding the existing economic insects of India and the comparative status of most of the really important noxious forms affecting Indian crops, the genuine K.D.s among Indian insects.

Some All-India Problems:—While the insect pest problems of the different areas of this vast country differ considerably in geographical, climatic, and other conditions and the varieties of crops grown in each region, there are a few insects which are more or less cosmopolitan and which may be considered as of 'all-India importance'. Such are those connected with locusts and some of the more important pests of crops extensively grown all over India, like cotton, sugarcane, rice, etc. The locust problem is as old as the Pharaohs and it has continued to exist all these generations as periodical visitations of the plague to the wonder and dismay of both the layman and the expert! The havoc these locusts cause to the country and the farmer in particular is too well-known to deserve any detailed description; rightly did the poet Cowley address the creature thus, 'Farmer he and Land-lord thou'!! We have definite records of two previous invasions of locusts in India; one is that of the migratory locust (*Acridium peregrinum*) which appeared all along N.W. India during 1889–90, an account of which Cotes[1] has given and the other, the outbreak of the Bombay locust (*Patanga succinta*) in 1903-4 in Bombay and the Deccan areas about which Lefroy[2] has given a graphic account. As though to remind the farmer and the Government that these temporary attentions paid to these spasmodic plagues of locusts are not satisfactory or of any permanent benefit, a large-scale outbreak of the desert locust (*Schistocera gregaria*) appeared during 1926–31 and by its serious depredations over extensive areas in Central India, Egypt and Turkey caused not only the Government of India but also those of countries like Egypt, Persia, etc., to move in the matter and start investigations on this important problem. This problem at present is not one for India alone but has become a trans-continental one for S. Europe,

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[1] On N.W. Locust, 1890.
[2] Mem. Dept. Agr. Ind. Ent. Series, I, 1906.

N. Africa, and S.W. Asia. The valuable investigations of Uvarao in discovering the two phases of this creature (the solitary and the swarming) and the recent studies made in India by Afzal Hussain and Ramachandra Rao, with their staff of research workers under the ægis of the Imperial Council of Agr. Research, have within the past few years added considerably to our knowledge of the bionomics of this dreaded insect and given us many valuable hints to be prepared for future contingencies. Speaking of cotton pests, the bollworms of one or both kinds (pink and the spotted) are receiving special atention in almost all provinces since cotton is cultivated practically all over India from the Punjab to the Cape Comorin; and under the auspices of the Indian Central Cotton Committee a considerable amount of work has been done in connection not only with the bollworms but also with other pests of cotton. The work on the spotted bollworm in Gujerat and the investigations on the pink bollworm in the Punjab, U.P., and the Deccan are some of the outstanding items of research in this connection. Another important crop which has begun to receive particular attention within the last few years is sugarcane. The insect pests of this crop which have increased in proportion to the gradual wide extension of area under cane in recent years, besides receiving some special attention in the different provinces under the local departments, have been honoured with the employment of a special sugarcane pests research officer by the Central Government, and important pests like the borers, leaf hoppers, etc., are being investigated all over India, especially in the Punjab, U.P., Bihar, and S. India.

Some Local Problems:—Besides the important problems noted above each province or special agricultural tract has its own specific insect problems and it often happens that one or more of these exist in more than one area. A few of the many such local subjects are those relating to the following: The cotton leaf roller, the wooly aphis, scales of fruits, pests of wheat, etc., in the Punjab and the N.W. Frontier Province; the sugarcane hopper, the cane borers, the rice hopper, cut worms, hairy caterpillars, jute pests, the linseed fly, rice pests, and mango insects in Bengal and Bihar; the chillies thrips, the betel vine bug, citrus scales, fig jassid, cabbage aphis, and the mango hopper in Bombay; the red hairy caterpillar, cholam bug, the ground nut leaf miner, paddy stem borer, the army worm, the rice grasshopper, the chillies thrips, and the citrus fruit moth in S. India; and the gram caterpillar infesting cotton, the rice gall fly, and the citrus pests in the Central Provinces. In each of these areas again are other problems connected with the sporadic activities of some insects which are not regular major pests, such as the Deccan grasshopper in Madras, the cane top borer of Bihar, the cotton stem beetle (*Sphenoptera*) of Mysore, cotton white fly in the Punjab, the rice leaf roller in Bengal. In addition to these are the insect problems of the hill plantations of the Punjab, Assam, and S. India which refer to pests specially of coffee, tea, rubber, cinchona, pepper, and cardamoms; some of these are specific and are of as much importance as those of cotton, cane or rice. The coffee stem borer of Mysore, the mosquito bug of tea in Assam and the S. Indian hills, the scales and berry borer of pepper, and the hairy caterpillars and thrips of cardamoms along the Western Ghats are among some of the notorious plantation pests. Among insect problems affecting forest products in India we have several peculiar to the different forest regions—tropical, subtropical, deciduous, evergreen, etc.—such as the pests of Teak, *Shorea Sissoo*, Sandal, and other valuable forest trees; a great deal of attention is, however, being paid to these and some intensive investigations have been made by the Central and Provincial Forest Departments.

These are some of the known insect problems of India and it is not unlikely that with the increase in the acreage of crops and the introduction of plants new to the country there is every probability of fresh pest problems arising in the future. It is also a curious phenomenon in different parts of India to find occasional changes in the status of certain insects from major to minor and *vice versa*; this also contributes to supplement the list of pest problems.

INSECT PEST CONTROL IN INDIA.

Faith and Magic Cures of Old :—In the same way as supernatural causes are attributed by our farmers to account for insect outbreaks, many an Indian farmer has firm belief in and often resorts to faith cures such as charms, mantras, magic, etc., believing that the pest which is an evil spirit or demon can be exorcised in these ways. Most of these methods consist in getting the professional local soothsayer or magician to perform some ceremonies to drive the pest and save the crop. I am told that in parts of Cochin and Travancore, when paddy fields are infected with pests like the rice-bug or the army worm, Christian ryots often resort to the method of sprinkling on the infested fields sanctified water obtained from Catholic priests. Some of the local methods reported to be resorted to in villages in some parts of the North Arcot District against a caterpillar pest on paddy were the sacrifice of a goat to the village deity and making cooly girls perform a ceremonial dance around the infested fields. This reminds me of the curious statement attributed to the naturalist Pliny—'A woman when led naked around an orchard protected it from caterpillars and this belief is said to be acted upon in parts of Italy according to the Italian Bastanze . . .' A few more statements are made in this manner which are too indecent to be reproduced here! The various harvest festivals called Pongals, Pujas, etc., performed as thanksgiving for a good harvest and prayers for a future good crop, are also said to have some significance in keeping off insect pests. In spite of the fact that many of these old methods are empirical and devised on imperfect knowledge of the insects and their habits, some at least among them have some practical value and must, therefore, have formed the nuclei from which a good many of our modern scientific methods must have developed. This is the case, I believe, in almost every country, especially in those where agriculture has been the chief occupation of the people. To confirm this belief, we often find in old publications references to several old ways of dealing with insect pests in Western countries similar to the following doggerel suggesting a prescription to check fleas:—

‘ When wormwood hath seed, get a handful or twaine,
To save against March to make flea refrain;
Where chamber is swept and wormwood is shrewn
No flea for his life dare abide to be known.’

In every country, therefore, there must have existed such beginnings and all later practices form the result of years of scientific study and experience—not only in trying old remedies to test the results, but applying them in ways suited to the habits of different insects after a thorough study of the life of each insect concerned. In India the evolution of the modern scientific methods must and can progress only step by step and it will be far from perfect for many years to come. From fatalism and faith cure to crude measures, and from the latter to intelligent and effective methods, is a gradual progress which has to be effected with a sound groundwork of agricultural education so that the future Indian ryot will be able to connect intelligently these methods with the habits of different pests and then be in a position to develop or discard the practices of past generations. Neither our educated citizen nor our rural farmer should forget the main fact that all control measures suggested against pests have been the result of trials with the accumulated experience of past generations, and that they are devised solely on a common sense basis without anything superhuman or mysterious underlying them. Once they remember this fact they will not be tempted very often to laugh at the entomologist and blame him for not finding magical and cure-all panaceas for checking all sorts of pests at one stroke. I cannot help adding that even among the educated classes—most of whom are not farmers—this sort of impression prevails in some places. Nor should the modern entomologist be blind to the fact that in some of the crude local practices lurk the germs of many a future successful remedy; he too should therefore be very careful in condemning any such methods before giving them his best attention.

Modern Methods of Insect Pest Control:—From these old rule of thumb measures, magic cures and cure-all nostrums, etc., some of which I have noted in a paper[1] on the subject in 1921, we will briefly examine some of the modern methods of insect pest control and the main principles underlying them. The most important of the numerous stimuli which have contributed to the increased study of Economic Entomology in modern days have undoubtedly been the various attempts made by man at devising ways and means of controlling pests of various kinds. Having realized that the frequent outbreaks of insect pests are chiefly the results of his own conscious or unconscious activities through centuries, man has also been devising, from time to time, various methods for keeping under control pests of different kinds in most of the countries where scientific methods of agriculture have become pretty well established. For an effective and economic application of the different methods of control so far known, it is essential that one should possess correct ideas of the insect pest he has to deal with. It may be emphasized that a knowledge of the life histories of injurious insects will be of very great help in adopting the measures suitable against particular pest ; such a knowledge will help any one as to when, where or how to strike the pest at its weakest point. There are some insects which lay eggs in clusters of hundreds or more in well-exposed places like hairy caterpillars on cholam, cotton, etc. ; whereas in the caterpillar or adult stage they are very active, dispersed, and difficult to check. In such cases, the insect can be easily and effectively checked by promptly collecting these egg clusters and destroying them. There are others in which thousands of caterpillars or grubs such as the tobacco worm (*Prodenia*) feed on each leaf or branch while there are other caterpillars having their vulnerable point in their pupal stage under the soil or in their adult conditions such as flying to lights, etc. Next to a knowledge of the life histories of insects, a study of their behaviour, their adaptations and response to environments and external stimuli forms one of the main lines of work for finding ways and means of control on scientific and economic lines. One striking instance of insect behaviour which would help the agricultural entomologist is what is known as *Phototropism*[2]—an attraction to light possessed by many insects. This behaviour is possessed by some of our important pests like the ground nut 'sural' and the paddy stem borer and the farmer can adopt lights with traps to control these. When such cases are known it will be found very easy and effective to adopt the proper control measures in time. An ignorant farmer allows these vulnerable points of insects pass unchecked and finds himself in a fix when the creature has increased in numbers and assumed serious proportions. When once we get some idea of the ways of an insect pest, methods of control become a matter of common sense. It need hardly be stated that the best remedial measure is the one which is practicable, cheap, and effective; otherwise the remedy will become more troublesome than the disease itself. Our farmer friends want ready-made medicines which will drive any kind of noxious insects like magic. But one who has known a little of the ways and habits of various insects can easily understand the ignorance underlying such demand. There is no doubt that as the farmer gets to know his important pests and their vagaries he will himself be able to devise such control measures which might suit specific pests and special localities. The different measures which can be adopted by man in the control of any pest, insect or any other organism, may be classed into two groups—preventive or prophylactic and direct or curative; the former consists of such measures which help to deter or keep away a pest from appearing and the latter includes such methods which are employed to destroy or check the further multiplications of a pest when it has already made its appearance. These two include the following different measures which may be adopted to meet different local conditions and individual insect forms:—

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[1] Some local practices in S. India on Insect Pest Control. *Agr. Jour. of India*, XVI (1921).

[2] Reference may be made to the paper on Insect Phototropism, by T. V. R. Ayyar and K P. Anantanarayana. *Mad. Agr. Journal*, XXII, 1934.

I. *Preventive or Prophylactic methods* :—
  Field and plant sanitation.
  Proper cultural methods (good seeds, proper cultivation, manure, irrigation, etc., removal of crop remains, stubble, etc.).
  Other precautions against pest infestation.

II. *Curative or direct methods* :—

(*a*) Agricultural	..	Deep ploughing, flooding, weeding, trap crops, crop rotation, etc.
(*b*) Mechanical	..	Collection by nets, bags, sticky boards, traps, light traps, etc.
(*c*) Chemical	..	Insecticides—applied by spraying, dusting, fumigation and as poison baits, larvicides, repellents, etc.
(*d*) Biological	..	Protection of natural enemies of pest such as insectivorous birds and animals, predators and parasites of pests and artificial propagation and use of such natural enemies; the use of fungi bacteria and other infectious diseases of insects.
(*e*) Legislative	..	Government regulations in connection with important serious chronic local pests and quarantine laws against exotic pests.

The well-known saying that 'Prevention is better than cure' is a very old maxim and is specially appropriate in many cases where we have to deal with diseases and pests of various kinds; but unfortunately the very sage advice contained in that pithy saying is more honoured in its breach than in its observance. It may be affirmed that in the case of many insect pests prophylactic measures will be found far more practicable and economical than those adopted to actually fight a disease or pest when it has made its appearance and when it often becomes too late to employ preventive measures, or, too difficult to resort to curative methods. In certain special cases, none but preventive measures will be found practicable. It is only when we find it impossible or impracticable to adopt intelligent and prompt preventive measures that the need arises for resorting to what are called direct methods. These latter include, as noted above, a variety of methods but the choice of the one suited to each pest depends a great deal on such important factors as the habits of the pest and the practicability of the method from the points of view of economy and local conditions. Among these direct measures I might add a few remarks on the chemical, biological and legislative measures, as these are now-a-days coming more prominently to the lime-light in Applied Entomology.

Chemical Methods :—Though the idea of controlling insect and other pests by application of medicines, etc., has been in existence from very early days, it was not, however, until the discovery of Paris green as an effective remedy for the Colorado beetle in the United States and of Bordeaux mixture for vine mildew in France, during the latter half of the last century that the use of reliable drugs and chemicals came into use on scientific and rational lines. Since then,. numerous insecticides and proprietary preparations have been discovered and at the present day, the use of insecticides has practically become a routine operation in pest infested fields in most of the regions of the world where scientific methods of agriculture are in vogue. Apart from the various references in early works to all sorts of local insect-killing preparations and drugs, the regular use of well-tried insecticides might be said to have been started for the first time in India by Government gardens and owners of coffee and tea estates in the hills during the eighties of the last century. We find that London Purple was used in the Botanical Gardens, Sahranpur, for the citrus caterpillar in 1889, and the trials with Kerosene emulsion and sulphur preparations for the coffee green bug and the tea mite were started in the hill plantations of S. India, Assam, and Ceylon. References to such attempts with insecticides like Chiswick compound, Gondal fluid, McDougall's insecticide, etc., and crudely-made spraying machines form interesting reading in the pages of the Indian Museum Notes (from 1891–1903), the earliest Indian periodical to record reliable facts on Economic Entomology, and in the valuable manual[1] on Tea by Watt and Mann. With the creation and organization of separate departments of Agriculture in the various Indian provinces and the establishment of the Agricultural Research Institute at Pusa in the early years of this century, the different aspects of scientific agriculture including that of insecticidal measures to check pests received favourable stimuli and considerable encouragement for rapid progress. The regular trials with insecticides on various crops on an organized scale and investigations in the direction of discovering suitable preparations for the different kinds of pests were formally started on the initiative of the famous economic entomologist who sacrificed his valuable life on an insecticidal investigation in 1925—I mean the late Professor Maxwell Lefroy who was the first Imperial Entomologist under the Government of India and under whom I had the unique privilege of serving my probation and picking up my first lessons in Economic Entomology over thirty years ago! It was Mr. Lefroy who introduced Lead arsenate into India for the first time and invented 'Crude oil emulsion' so well-known and popular at present as a standard contact insecticide; the former substance was first tried for the gipsy moth caterpillar in the eastern states of America and the latter is an improved recipe on the common Kerosene emulsion. These two preparations are at present two of the best known and widely used insecticides in India. Some of Lefroy's trials with insecticides in Pusa are to be found in his bulletin of 1908.[1]

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[1] Watt and Mann, 'Pests and Blights of Tea' (1903).

Speaking of insecticides in general and especially of poisonous ones which are the really effective ones against grasshoppers, beetles, caterpillars, etc., one cannot grow very enthusiastic under conditions prevailing in a country like India. Any one who has any correct ideas regarding agricultural conditions prevailing in India, especially regarding the comparatively small size of the Indian holdings, the proverbial poverty of Indian agriculturists and the equally poor returns got out of such staple food crops like paddy and millets, can at once find out that insecticidal measures against pests on such field crops are quite impracticable and often uneconomic. On the other hand, experience has shown that the use of insecticides to fight pests infesting valuable and well-paying crops of different kinds, like cotton, tobacco, sugarcane, etc., is quite a practical and economic proposition. The rapid spread in these days of fruit growing, horticulture, kitchen gardening with trials of other remunerative crops is beginning to offer a very wide and encouraging scope for the adoption of insecticidal methods. Trials in this direction have been and are being made by Governments and planters with success in various cases. Unfortunately conditions prevalent in India have not sufficiently improved to recommend the use of insecticides on a wider scale, especially by the illiterate Indian farmer. Until the standard of literacy improves or insecticides harmless to man are substituted it will not be quite safe to entrust such poisons in the hands of our ryots and the operations must be carried on only by trained hands or under expert supervision. It may be interesting in this connection to find that trials are being made to produce local insecticides, especially from vegetables like *Derris*, etc., in Mysore and other places. I would refer those interested in this subject of insecticides with special reference to India to my paper issued in 1934.[1]

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[1] Treatment and observation of crop pests on the Pusa farm by Lefroy and Misra. Bull. No. 10, 1908.

Biological Methods :—Coming to the biological methods, a topic which has now-a-days come very much to the forefront in connection with pest control, a few words may be added. In brief, this method of pest control consists in the utilization of the natural enemies of a pest to check its multiplication and serious effects. This process is not absent in nature as has been explained in speaking of the balance of life and its maintenance among living beings; but when nature is helped by artificial methods to encourage and help such natural enemies in checking a pest these together constitute what are generally known as biological methods of pest control. The first and most essential preparation in the adoption of any such biological control is a thorough knowledge of the natural enemies of the pest one wishes to control. Among the various enemies of insects in nature the commonest are insectivorous birds, reptiles, frogs, toads, some worms, and members of the insect group as well. It is found that among such different agencies insect enemies of insects (*Entomophagous insects*) play a very remarkable rôle in maintaining the balance of life in nature, and in the words of Gossard,[2] 'Except for the check put upon insect multiplication through warfare within the insect household, by which one species of insect destroys its relatives, no informed naturalist would expect the survival of the human race for a longer period than five or six years. Not only would man's food supply be appropriated by his insect enemies, but it would be impossible for him to withstand the withering march of malaria, yellow fever, typhoid, bubonic plague, sleeping sickness, and other maladies transmitted by insect carriers'. It is important, however, to note that among these insect enemies only such forms can be utilized in this method of control which depend for their food on particular species which are injurious to man's belongings and not others which feed indiscriminately on various other forms. Prominent among such friendly insects are the bulk of beetles known as 'Lady birds', the lacewing flies, hover flies, bristle flies, and the hordes of parasitic hymenoptera. In a couple of papers, one [1] on Entomophagous insects and the other [2] on biological control, the latter of which was read before this section of the Congress in Benares in 1925, I have attempted to give some information on some of these forms with special reference to S. India and have also discussed the different methods and possibilities of biological control for insect pests in India. *Predators* :—All these natural enemies are either predatory or parasitic in habits. Those of the former kind hunt their insect prey and feed on them like wild beasts; on the other hand, the parasitic ones, instead of instantly killing their hosts, use them as food for their offspring by depositing eggs on or into their bodies; the larvæ emerging out of these eggs grow into adults at the expense of the body contents of the host which is gradually killed. Though there are many insects with predatory habits like dragon flies, tiger beetles, assassin bugs, predatory wasps, robber flies, etc., the lady birds are found to be extremely useful in checking several crop pests such as plant lice, scales, mealy bugs, etc. *Parasites* :—The work of parasitic insects is considered in many cases to be far more efficacious as natural enemies of pests—'Outbreaks of injurious insects', says Howard, 'are frequently stopped as if by magic by the work of insect enemies of pests'—and this is done very remarkably by parasitic wasps. With regard to the work of these parasitic hymenoptera one cannot help repeating Sharpe's remarks about them—'The division parasitic hymenoptera is one of the most neglected of the great groups of insects, though it is perhaps of greater economic importance to mankind than any other'. This large conspectus of parasitic wasps includes thousands of species exhibiting remarkable variations in structure and habits, and a thorough study of the bionomics of even a few of these interesting insects will not only help the economic entomologist who may wish to utilize them for pest control, but will be found to be of absorbing and fascinating interest even to the pure zoologist. India abounds in numerous parasitic wasps carrying on their remarkable work of pest control often unknown and unnoticed by man, but unfortunately our knowledge of their life activities has till now been very very meagre. During the past few years I have been trying to do some little work in this direction so far as S. India is concerned as may be seen from my papers [3] on para-

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[1] Insecticides and their Uses in India. *Mad. Agr. Jour.* (1934).

[2] *Jour. Ec. Ent.*, II, 1909.

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[1] Economic Importance of Entomophagous Insects. *Mad. Agr. Jour.*, XX, 1932.

[2] Some Biological Methods of Insect Pest Control. *Mad. Agr. Jour.*, XIII, 1932.

[3] Some of the more important of them are:—

(*a*) On some insect parasites of Indian crop pests. Repts. of 3rd, 4th and 5th Meetings, Pusa ;

(*b*) Parasitic hymenoptera of economic importance in S. India. Bull. E. Res., London, 1926 ;

sites in general and on the groups of Braconidæ and Chalcidæ in particular. Mani's recent Catalogue[1] of Indian Chalcid wasps is an exceedingly valuable contribution in this direction. The work of Hussain and Mathur[2] on the parasites of the cotton bollworms is another excellent example of work done in this direction in the Punjab.

Coming to the methods of utilization of these helpful forms in checking insect pests the essential pre-requisites are a proper recognition, correct identification, and a thorough study of the bionomics of the pest to be controlled and the natural enemy or enemies proposed to be utilized for such a control in all their aspects and inter-relations. Such attitudes are extremely important because it will be very often found, especially in the case of parasites, that in many cases what we consider a beneficial insect may not in fact be one, in spite of its being a parasite. It may be a parasite on a parasite (a *hyper-parasite*) which means it is doing harm by destroying a beneficial parasite; as the saying goes:

'Those fleas that do us tease
Have other fleas that bite them
And those in turn have other fleas
And so *ad infinitum.*'

In many cases of insect pests one often comes across what may be called a complex of hosts and parasites in relation to a single insect pest. There may be predators, parasites, hyper-parasites, super-parasites, etc., etc., of different categories which might interfere with the desired effect of biological control. As such it is extremely essential to have very accurate ideas of all the insect associates of a pest so that those which are harmful to our purpose may be eliminated. In South India, for instance, during the trials of biological methods for the cocoanut pest (*Nephantis*) it was found that there existed a complex of over fifteen insects associated with the pest in different capacities !! (see fig. on p. 302). The methods generally adopted after getting the essential data regarding the pests and their natural enemies are : (1) affording all possible facilities for these enemies to multiply, (2) wherever necessary and possible the introduction of such natural enemies from a different tract or country where they are found acting as efficient checks against some pest or pests similar to the ones we have to control. In fact the whole idea is to try to restore as far as possible by artificial means the original natural

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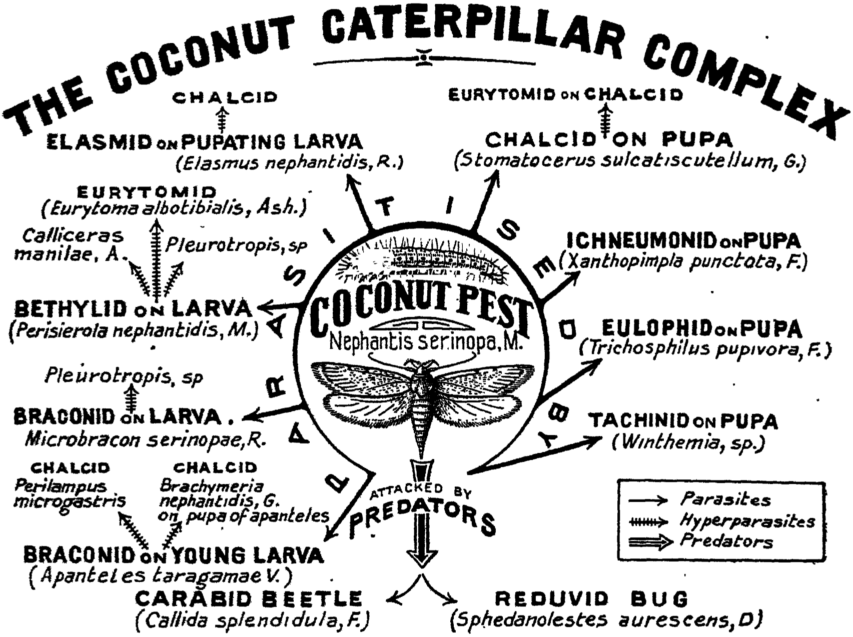
(c) A contribution to our knowledge of S. Indian Braconidæ. Mem. Dept. Agr. Ent. Ser., 1928 ;

(d) A check list of Indo-Ceylonese Chalcid wasps. Spolia Zeylanica, Ceylon, 1925.

[1] Catalogue of Ind. 'Chalcidoidæ', 1938.

[2] Cotton Bollworm Parasites, 4th and 5th Ent. Meetings Repts., Pusa, 1921 and 1923.

balance of life. The earliest and classical example of such pioneer attempts in the successful introduction of natural enemies of insect pests is the well-known introduction of the famous lady-bird beetle (*Novius cardinalis*) in 1889 by Kœble from Australia into California to control the notorious fluted scale (*Icerya purchasi M.*). As a result of this early and successful introduction; numerous other attempts have since been made in different parts of the world and some measure of success has been reported in many cases. The records of success or failure of many of these attempts depend a good deal on the view-point of each worker; while many an attempt is reported as a complete success evidences are wanting to confirm such. The following remarks of the well-known worker H. S. Smith support this view: 'If you go over the old literature on this subject in California you will find that the black scale problem was solved by the introduction of *Rhizobius* in 1890; it was solved again in 1900 by the introduction of *Scutellista*. But we still spend in excess of a million dollars a year in S. California on other methods against this pest! The same was true in Hawaii; for many years they claimed that the greatest example of biological control was that of the sugarcane hopper by one or two egg parasites and later introductions. Now they admit that control by these egg parasites was far from satisfactory!!' The history



and progress of these trials in modern times is a very interesting subject. This method of control has so far been tried on an organized scale against two pests in S. India; these two are the fluted scale (*Icerya*), a foreign insect which was introduced into the Nilgiris probably from Australia somewhere about 1927-28, and the other an indigenous pest, the cocoanut caterpillar (*Nephantis serinopa*). For the former, the well-known insect enemy of the scale, the lady-bird beetle (*Novius*), was introduced and within two or three years the progress of the pest was considerably arrested though it has not been completely exterminated. With regard to the cocoanut caterpillar considerable work has been done in the study of the bionomics, its parasites and predators, and their interrelationships. Some of the parasites have also been found to do some appreciable work in controlling the pest now and then. But as I said once before there is a regular complex of insects, both beneficial and injurious, passing their lives in relation to this pest. In Mysore we find that this method is being tried with very encouraging results by Subramanium [1] for cane borers, the important natural enemy used being a well-known minute wasp (*Trichogramma*). This work in Mysore, which is showing appreciable results and which is the first of its kind in India against borers, is attracting the attention of sugarcane growers all over India and it is highly creditable to the Mysore Agricultural Department and especially to its Entomologist who is carrying on this pioneer work and who is also helping other workers in India in this interesting line of pest control. It will be interesting to watch the results of other attempts also in the different parts of India. Before leaving this topic I may be permitted to add that the method is not such an easy thing as many people often think and in most cases it acts only as a supplement to ordinary cultural and mechanical methods of pest control. Nor is the procedure so smooth working considering the parasite complexes of many of these pests which demand a thorough study and elucidation of such factors and phenomena as hyper-parasitism, super-parasitism, multi-parasitism, host-parasite relations, the food of the adult parasites, influence of weather conditions on the pest and the parasite, and a host of other factors before anything definite can be achieved successfully. With some people the idea of this method has now become fashionable and is tending, in the words of Dr. Thompson, to degenerate into a kind of superstition and fad and unless proper ideas are inculcated on this subject this method can easily become quackery !' But if carried along proper lines this method has a very bright future before it and is sure to help the cultivator remarkably in checking the ravages of injurious insects.

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[1] Experiments with *Trichogramma* for cane borer in Mysore. *Ind. Jour. Agr. Sc.*, VII, 1937.

Speaking of biological methods of control in India I might just refer to the case of an introduced insect which has controlled a notorious plant pest in S. India—I mean the minute cochineal insect (*Dactylopius*) and its remarkable and spectacular work in eradicating prickly pear weed. This has been a remarkable phenomenon in S. India and can be considered a notable achievement in the biological control of a veritable plant pest. An account of the work of this insect is given in my paper.[1]

Legislative Methods:—Before I finish with the subject of pest control a few words may also be added on legislative measures in pest control. I have already referred before to human interference with the balance of life in nature; among the many such human activities one has been the indiscriminate transportation of plants and animals from one country to another, without in the least realizing or foreseeing the disadvantages and the often disastrous results of many such introductions. We have some examples of how man, without any evil intention, has been responsible for bringing about a very undesirable state of affairs in different regions of the world by thoughtless introductions of different forms of life from one region into another. Though the geographical position of India is more or less isolated, situated as she is, clearly separated by natural boundaries of mountain walls or seas from other regions, in these days of quick and easy transport facilities for all sorts of animals and vegetable products not only by land and sea but also by air, there is every likelihood of undesirable and harmful exotic forms, gaining admission into the country without our knowledge. This is the case particularly with lower animals and plants of different kinds. Examples are not wanting of the disastrous after-effects of such thoughtless introductions of exotic forms in different countries. We have already a few introduced forms like the *Potato borer*, the *Diamond back moth*, and the *Coffee green bug* which are causing considerable havoc in their new homes.

About twenty years ago in a paper,[2] 'On some foreign insect pests which we do not want in India', I tried to draw the attention of agricultural entomologists in India to some of the notorious foreign insect pests and the possibilities of any of them getting entry into India and the need for vigilance on that score with a few suggestions to prevent such unwanted arrivals. I may also add that since then what was apprehended did happen unfortunately in the case of at least one of these foreign K.D.s, the *Cottony cushion scale*, the dreaded citrus pest of Australia and other regions; somehow this insect had gained admission and was noted for the first time on Australian wattles on the Nilgiris hills during 1928 and it has not yet been possible to fix the responsibility of this event on anyone! Luckily the introduction by the Madras Government of the predatory beetle which preys on this creature and keeps it in check has not allowed the pest to multiply and become a menace though it still lingers on the Nilgiris on wattles and to some extent on citrus plants also. Another of these unwanted pests—the San Jose scale—a dreaded foreign fruit pest has entered the country from the North into the Punjab, having established itself in Cashmere. One other creature in my 1919 list of undesirables, the *Codling moth*, a notorious pest of apples in other lands, is trying to enter the country through Baluchistan. We in India have any number of indigenous pests giving us enough and more trouble; we would therefore be adding to our existing troubles if we allow alien pests (animals or even human) to gain entry into the country. Till about 1906 there were no restrictions of any kind and any one was quite at liberty to dump into the country any forms of animals or plants; and with the gradual increase of facilities for easy transportation both by land and sea, chances for exotic pests considerably increased not only for reaching the country but even to distribute themselves free into the distant parts of the interior. In 1906, however, the Government of India apprehending danger moved in the matter and after preliminary enquiries and reports by experts passed an Act (Act II of 1914) to prevent the introduction into British India of any insect fungus or other pest destructive to crops and this was supplemented in 1917 by a more comprehensive statute. In spite of such restrictions it must be admitted that there are various chances of pests of different kinds gaining admission unless these restrictions are thoroughly overhauled and carefully worked out, and men properly trained for this work are deputed to attend to this duty at the important gates of entry. A more thorough set of rules covering all possible imports of a suspicious nature should be framed and a regular system of plant quarantine should be established. In 1934 the National Plant Board of the United States of America issued a set of regulations approved by all the 48 States under the title 'The Principles of Plant Quarantine' which is a valuable contribution setting forth the principles that ought to be applied in the establishment and enforcement of plant quarantines. These may be found in my paper [1] on 'The economic danger in the introduction of foreign plants and animals'. The legislative measures referred to so far apply to exotic pests; another set of rules is generally laid down for indigenous pests of the different tracts of the country, measures to prevent these forms spreading into areas which are free from the pest in the same country. In South India we have a Pest Act of this kind which is occasionally applied to certain areas in connection with the Red hairy caterpillar of dry crops, the Cotton stem weevil, and the Cocoanut caterpillar pest of the West Coast. In this manner Governments may have to resort to legislative enactments when other methods prove either impracticable or ineffective.

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[1] The scale insects of the Prickly pear in S. India and their economic importance. *Agr. and Live Stock in India*, Vol. I, 1931.

[2] *Agr. Jour. of India*, XIV, 1919.

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[1] *Mad. Agr. Jour.*, XXI, 1933.

SOME OBSERVATIONS ON EXISTING CONDITIONS AND SUGGESTIONS REGARDING THE FUTURE OF ECONOMIC ENTOMOLOGY IN INDIA.

Having dwelt briefly on some of the more important aspects in the relations between insects and Indian agriculture as they exist at present, I venture to make a few general observations and suggestions for what they are worth on the work done so far and the future possibilities.

A Programme of Work:—I believe that in any systematic attempt to utilize in a practical manner the knowledge gained of the different aspects of the science of Entomology which have a direct bearing on the agricultural progress of any country the following should be the main items to be kept prominently in view and attended to as far as possible in their chronological sequence in any ideal programme of work, *viz.*, careful observations and intensive studies on the various aspects of the insects of the country which have an economic importance, the training up of men for this line of work, the education of the farmer in the essential features of the subject, and finally helping him to utilize the knowledge so gained to control injurious insects and take advantage of the activities of those forms which are beneficial. If these ideals are satisfactorily attended to, the entomologist may be said to have carried out his mission successfully and, as some enthusiastic breeders believe, the services of an entomologist, or a mycologist may be terminated for good; but, it is needless to add that such a consummation, though devoutedly to be wished, is one which may perhaps take some generations to be accomplished if at all.

In India, the study of Economic Entomology on scientific lines may be said to have started from the year 1903 when the Departments of Agriculture under the Central and many of the Provincial Governments were reorganized. During the past three decades, the chief items of work in connection with Agricultural Entomology included studies of the comparative incidence of the different forms with the extent and nature of injury caused, studies on the life histories and habits of some of the more important ones, some observations into the bionomics of some of their natural enemies and, finally, the adoption of such control measures as have become practicable with the limited data so far gathered. In fact, in spite of our very meagre knowledge of the several aspects of Indian insects it was the last item of pest control on which greater attention had to be paid for obvious reasons. Though a considerable amount of valuable spade work has been turned out with regard to the study and investigations on Indian insect pests as is evident from the numerous entomological publications issued from time to time from different parts of India during the past few years, a good deal yet remains to be done. I may quote one of my predecessors[1] in this chair to this effect, 'The problem of crop pests and diseases is indeed one which demands considerably more attention at our hands than many others, and its importance is bound to increase as intensive cultivation, large scale cultivation of commercial crops, and the growth of superior high yielding varieties evolved by the plant breeders, increase'. As one who was engaged in this line of work for some years I may be permitted to make a few observations on certain aspects of these investigations and studies which I consider worthy of some special attention.

Systematic Work:—While I yield to none in my sincere appreciation of the great importance of the work of the economic entomologist or in my disapproval of the cheap sneer of calling Applied Entomology a 'mere bundle of methods', as one of my old bosses used to do with all the affection of a step-mother, I may be allowed to point out that there is a deplorable tendency in some quarters to belittle the value of work in the general or systematic aspects of Entomology on the score, that such work may not be of immediate economic importance; such an attitude on the part of one who professes to be a scientist cannot be sufficiently deprecated; but unfortunately this spirit is prevalent even among some of the present-day experts in different institutions. I might state without fear of contradiction that no entomological work of an applied nature can progress on correct lines without the sure foundation of sufficient studies on the general and systematic aspects of the science. I would invite the attention of such short-sighted persons to the opinions of some eminent zoologists. 'It is the systematist', says Prof. Pearl of Johns Hopkins University, 'who has furnished the bricks with which the whole structure of biological knowledge has been reared; without his labours the facts of organic evolution could scarcely have been perceived, and it is he who to-day really sets the basic problems for the geneticist and the student of experimental evolution'. And in the words of Gahan, 'Without the fundamental work of the taxonomist, the great mine of entomological literature would not exist and the accumulation of knowledge would be largely limited to what one could only personally observe and remember'. The first real economic entomologists were predominantly morphological and systematic entomologists, and without a thorough knowledge of the relations, habits, and method of identification of each insect we have to deal with, it will be not only difficult to proceed, but the task might be found risky and affecting the reputation of the applied entomologists. I would therefore invite the attention of future workers in Economic Entomology in India to bear in mind the well-known fact that systematic studies are the fundamental basis of practically all Applied Biology. Discrimination between species is the starting point of the majority of our biological problems, and ignorance of and indifference to this fact has invalidated many items of biological work in the past. *Ecology* :—Another important aspect of the subject of Economic Entomology—which I venture to lay stress on—is the great necessity for supplementing our past studies with field observations on the bionomics of injurious insects, to get some definite idea regarding the nature, effect, and other characters of their natural environments, the influences exerted by them on their surroundings, etc. etc., a subject which is known as 'Ecology' and which is found to play a very important part in insect pest studies and control. 'Animal Ecology', as Elton says, 'is a branch of Zoology which is perhaps more able to offer immediate practical help to mankind than any of the others and in the present rather parlous state of civilization it would seem particularly important to include it in the training of young zoologists. It is the real foundation for Applied Biology. The tropical entomologist, mycologist or weed killer will only be fulfilling his functions properly if he is first and foremost an ecologist'. In fact, most of our problems in Economic Entomology resolve themselves into problems of Ecology. Applied Entomology is to a very great extent a field science and in the matter of pest control the various data collected by observation in the fields will go a great deal in helping us to devise ways and means of relief. There are of course signs now-a-days to show that the value of ecological studies is being realized as is found especially in the case of the locust research studies and to a certain extent in studies connected with the cotton bollworm and a few pests here and there; here I am only attempting to emphasize the need for such studies and commend the same to our future workers.

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[1] A. K. Y. Iyer, Indore, 1936.

Bioclimatics :—The next aspect of the work to which I wish to draw the attention of workers and which is closely related to ecological studies is the usefulness of a knowledge of Agricultural Meteorology in relation to insects. That a knowledge of weather conditions is in certain cases very necessary and in other cases very helpful to the farmer in his agricultural operations is well known to most of our farmers, but it is doubtful whether the subject has received sufficient attention from an entomological point of view in this country. Investigations on the interrelation of plants, animals, climates, seasons, and distribution (what is known as *Bioclimatics* or *Entomoclimatics*) will be found very useful to farmers in all areas, especially where there are major insect pests appearing year after year and causing serious damage to crops. Beyond the knowledge that one pest or other appears every year in various degrees of intensity the farmer has hardly any definite ideas as to the why or wherefore of such phenomena though, of course, he has his own explanation expressed in such trite expressions as no rains, early rains, late rains, too much rains, no winds, unfavourable weather, and wind, etc. etc. A knowledge of the nature of the response of the insect to its environment and climate is often missed for want of exact data on the microclimatics of the crops and the insect concerned, and hence we are quite unaware of the particular circumstances under which an insect multiplies to become a pest. The influence exercised by weather factors—chiefly temperature and humidity on the development and behaviour of insects—has been studied by several eminent scientists in the West, by means of elaborate tests and accurate data; but systematic work on Insect Ecology and the study of weather in relation to pest control or outbreaks are only of recent origin. The results achieved so far appear so encouraging that in the investigations of all modern entomological problems, the study of weather in relation to pest incidence has come to be considered as important as the work on the life history and bionomics of the insects concerned. In the Meteorological Conference in 1934 in London, Uvarov, Gryse and many other entomological workers have laid special emphasis on taking microclimatic observations and studying the environment of insect pests. An excellent example of work in this direction is that in connection with the researches on the desert locust by Y. R. Rao.[1] In South India we have noted some good examples of insects the behaviours of which have been remarkably shaped by weather conditions. Sporadic outbreaks of the army worm on paddy (*Spodoptera*) every year in some localities or other, the sudden increase in the infestation of cocoanut palms by the black-headed caterpillar (*Nephantis*) or the sudden increase of the parasites on the latter during certain seasons of the year, the appearance of the rice grasshopper (*Hieroglyphus*) in a virulent form during certain years in such distant places as Malabar in the south and Ganjam in the north, the rapid multiplication and the mass emergence of the red hairy caterpillar (*Amsacta*) after the first rains in certain localities, the very high percentage of attack by paddy stem borer (*Schoenobius*) in certain rain-fed areas as compared to other paddy-growing centres, the equally surprising and phenomenal outbreaks of the paddy borer beetle (*Rhizopertha*) in stored paddy in some of the southern districts, are but a few of the well-known instances which clearly give us some definite indications of the relationships existing between pest outbreaks and weather. The relations of insects to rain and bright sunshine are also striking. Often swarms of butterflies and locusts migrate and this has perhaps some relation to the existing or approaching weather conditions.

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[1] Locust invasion of 1935 in N.W. India. *Ind. Jour. Agr. Sc.*, 1936.

But it must be admitted that we are in need of a good deal of further information as to why sometimes there occur serious outbreaks in unexpected quarters. There are thus several *lacunæ* to be filled up in our knowledge before we can be in a position to utilize such knowledge to supply accurate and timely predictions of insect outbreaks. My views on this subject may be found in a paper [1] published in 1935. I sincerely feel that studies on Agricultural Meteorology with the idea of utilizing the knowledge gained by weather studies in relation to insect behaviour might open up valuable avenues to the agricultural entomologist in pest control.

Men and Methods :—Referring to the last two items in the ideal programme I have pointed out above, *viz.*, the education of the farmer and the attempts to utilize the fruits of the knowledge so far gained for the material welfare of the country, it has to be confessed that a great deal yet remains to be accomplished. To those of us who are familiar with work of such a nature along new lines, the reason is not far to seek. It is neither neglect nor indifference; for every economic entomologist knows that these two items of the programme together form the real goal of the whole work and that the first few of it are but preliminary ones and accessories to the accomplishment of the main theme. Unless some appreciable headway is made in training up a band of capable men for this work, and before some substantial knowledge of the more important insects of the country is gained, it will be rash to approach the farmer or help him to utilize the results of any investigations; in other words, as in human ailments, every injury caused to plants by insects has to be carefully diagnosed and studied before remedial measures are resorted to. Otherwise, in many cases the remedies adopted as a result of imperfect knowledge may prove worse than the disease. Thus during the past few decades a considerable amount of spade work has been done to form a basis for the future. Though a period of three decades or four is nothing for the solution of many an important scientific problem, we must admit that we are now come to a stage when the more serious, more telling and more utilitarian part of the work of the entomologist has to begin. While education and research including the training up of new men and the investigation of insects in their different aspects will have to be continued side by side for a very long time to come, I believe the time is now ripe enough for earnest beginnings to be made to approach the farmer and bring home to him some of the facts relating to the applied aspects of the science. For any work of this nature which requires not only a proper grasp of the subject to be utilized but also one which demands certain human qualities for controlling and carrying on educative and propaganda work outside the pale of scientific circles, we want the right sort of 'men and methods'. Men for such work must be those thoroughly acquainted with different local conditions, able to move and converse freely with the farmers, realize their difficulties, understand their prejudices, and respect their feelings; they must be persons who have, more than anything else, the interest of the country at heart and sufficient enthusiasm and earnestness for the work. It is needless to add that if sons of the soil with these desirable qualities are found they will form the best medium to carry on the work satisfactorily. In a paper read by Lefroy and Howlett before the International Congress of Entomology held at Brussels in 1910 on the 'Progress of Economic Entomology in India' they have sounded the true note when they remarked thus, 'Where there is a body of men from their own community trained in scientific agriculture, able to adapt it to the needs of the country and to the peculiar conditions of their agriculture, the benefits of scientific knowledge and its practical application might be put to them in a way they would appreciate and understand'. With regard to the attitude of the official entomologist in his dealings with farmers, a few suggestions may be offered. When any report of a serious outbreak of pests is received from any place the controlling officer himself or a subordinate of some experience and standing should try to visit the locality. A good deal can be done to satisfy the farmers by the controlling officer himself visiting the place, interviewing the farmers of the locality, and doing whatever is possible under the circumstances, and if nothing could be done in any bad case, he could easily gain the confidence of his *clientele* by personally explaining the practical difficulties in the way, and thereby convincing them of the sincerity of his attempts. It is a very bad policy to send a raw recruit or a novice in the art in response to such reports, simply as a sort of formality; in my opinion it is false economy and in many cases, due to want of tact of the young men, the reputation of the entomological section itself may suffer. The expert should never give indifferent advice, nor should he suggest methods which are quite impracticable and unsuited to the local conditions. For, 'the subject matter of Economic Entomology is not', as Forbes says, 'insects alone, nor plants alone, nor farming alone. One may be a most excellent entomologist or botanist or he may have the whole theory and practice of Agriculture at his tongue's end and his finger's end as well, and yet be without knowledge or resources when brought face to face with a new practical problem in Economic Entomology. The subject is essentially the relation of these things to each other, of insect to plant and of plant to insect and of both these to the purpose and operations of the farm and it involves some knowledge of all of them'. In short, the successful economic entomologist, as characterized by

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[1] Agr. Meteorology in its relation to insect pests. By T. V. R. Ayyar and K. P. Anantnarayana. *Mad. Agr. Jour.*, 1935.

Washburn, 'is essentially a practical man keenly observant with a knowledge of Botany and general Agriculture, a judge of human nature, a good mixer, a good speaker and perhaps a good politician in the cleanest sense of the term; he is systematic in his work, a careful note-taker and just and generous to his follow workers, giving them ungrudging credit for independent initiative and work'.

Organization :—As regards the organization needed for this work in India I have to state that the existing staff and arrangements of Agricultural Departments are quite insufficient to cope with the increasing importance of insect pests in agriculture. While in the U.S.A. there are not less than 515 entomological workers (not including the subordinates who are not included in the civil list) under the Bureau of Entomology, we in India have not even a hundred workers. As regards the activities of the U.S. Bureau of Entomology the following will give us some idea:—

> 'The U.S. Bureau of Entomology has the largest organization in the world for investigation and research on insect pests. On June 30, 1929, it was actively engaged on seventy-six major projects in the investigation of at least five hundred insects known to be injurious to agriculture. There are, however, numerous other insects involved in these investigations which are not included in the primary list. Remedial treatment has been found for every important injurious insect in the United States, but continued efforts are being made to find something more effective or something simpler or less expensive. The entomological activities of the Bureau are considered under the following groups: Deciduous fruit—insect investigations; cereal and forage insect investigations; forest and shade—tree insect investigations; truck—crop insect investigations; stored product insect investigations; tropical, sub-tropical and ornamental plant insect investigations; investigations of insects affecting the health of man and animals; taxonomy of insects; bioclimatics; insect pathology; insect morphology; exchange of useful insects; history of Economic Entomology; and insect pest survey [1].'

In 1917 Fletcher, the then Imperial Entomologist for India, submitted proposals for a similar organization for this country on a moderate scale but unfortunately it was not seriously considered by Government. While Fletcher wanted only an annual budget of Rs.5,00,000 the budget of the U.S.A. Bureau for the year 1930 was 2,199,178 Dollars or about 60,00,000 Rupees!!

Co-operation :—I cannot in this connection refrain from emphasizing the great need on the part of economic entomologists for co-operation with workers in the allied sciences such as the Plant breeder, the Mycologist, the Biochemist, and the Agriculturist. In these days of specialization in research we occasionally come across scientists who have no regard for any other scientific subject than their own; this is certainly a very undesirable trait, for, in the words of Riley, 'The scientist who tries to build a wall against what he regards as rival subjects will only succeed in ensuring himself against recognition of himself by his followers'. I would add that while in these days there is need for specialization on the part of different biological workers each in his own branch, a general knowledge on the part of each of the specialists of what others are engaged in will be of great advantage to all; for, now-a-days, there arise numerous biological problems which call for co-operation and team work.

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[1] G. A. Weber—The U.S.A. Bureau of Entomology (1930).

Applied Biology in India:—Many problems in Agriculture are such as can only be solved with the united efforts of workers in the different natural sciences. Speaking of the different sciences I am tempted to make a few observations on the position of the applied sciences in India, especially that of Applied Biology which forms part and parcel of the subject of Agriculture. I am constrained to state that the applied aspects of Biology do not receive as much attention as they deserve in any of the Indian universities, even in those where Biology and Zoology are included in the curricula of studies; evidently this is due to the time-honoured custom of catering purely to intellectual and academic needs. I may also state that even in recent years there were prevalent among many scientists, especially those trained in or connected with many universities of Great Britain, some short-sighted and unfortunate ideas regarding the applied aspects of the natural sciences. Many of them have been feeling that Pure Botany or Pure Zoology is of higher scientific status than Applied Biology and that the economic zoologist or botanist occupies a, lower caste. At the International Conference of Botanists in London in 1930 one of the leaders exclaimed thus, 'At this conference let us have pure Botany, real Botany; we do not want all that applied stuff'; another so-called pure botanist remarked: 'We discover facts and principles and you merely apply them to particular problems and nothing more'. In certain quarters there is often a three-cornered fight between the research worker, the university professor, and the applied biologist. The research worker is looked upon by some as an inoffensive but curious member of the social order moving in his own rut and knowing hardly anything of the outside world; the teacher is snubbed as an academic automaton whose place can be easily replaced by a gramophone, and the applied biologist is regarded as a boorish plug of a farmer or mechanic with neither culture nor status. I have worked in all the three capacities and in my opinion all the arguments are but half truths. It is, however, gratifying to note that all this snobbery and mutual bickerings, especially those between the pure scientist and the applied scientist, are gradually disappearing and that they are beginning to realize that it is the proper balance between the two aspects that should be maintained. In the words of Professor Coulter, 'The physical needs of man, great as they may be, must never obscure the intellectual needs of man, especially as the trained intellect is the speediest agent in meeting physical needs. On the other hand, the intellectual needs of man, noble as they may be, must never lose sight of the fact that the speediest results are obtained by the enormous increase of experimental work under the pressure of physical necessity'. Nor has it to be forgotten that it is on the foundation of Agriculture that all human activities and thoughts depend in the last resort and that Agriculture is mainly Applied Biology. Above all, the late war and the events that have followed have demonstrated with great force the absolute dependence of all phases of industrial life upon the single industry, agriculture, which, with its associated activities, forms the one primal all-essential requisite in the successful prosecution of any enterprise, be it war or peace. The realization of these stern facts has within recent years given a stimulus to the advance of the applied sciences. Applied Chemistry, Applied Physics, and Economic Biology have now-a-days begun to loom large in scientific circles and experts in responsible quarters have begun to feel that the motto of applied sciences and pure sciences should be the same, *viz.* 'a practice based on sciences and a science that illuminates and extends practice'. It may also be concluded generally that all science is practically one though for conveniences it is divided into different aspects, that pure science is often immensely practical, that applied science is often very pure, and that between the two there is no dividing line, both being essential for the intellectual and material needs of man. My only excuse for this digression is to invite the attention of both scientific institutions and universities in India to the need for giving greater encouragement to the applied aspects of the sciences which are essential to meet the many pressing material needs of our country.

CONCLUSION.

I might now revert to my main theme and point out to all interested in the agricultural prosperity of our land with all the emphasis at my command, that the insect problems of the Indian farmer are increasing day by day and it is up to Governments and the educated farmers to do all that should be done to save the numerous valuable products of the country from the clutches of noxious insects. I cannot do better than repeat Prof. Maskew's very apt remarks in conclusion, *viz.* 'The most important, the most vital thing in all the world is to get something to eat; if all of us here present, or mankind in general, were positively unable to obtain anything to eat for the space of one week, the affairs of this world, commercial or otherwise, would soon become of no more consequence than duckweed upon the surface of a pond. Without something to eat there would be no coal mined, no steel forged, no freight cars rolling. Agriculture in its broadest sense is the source of something to eat, and hence the original source of all subsequent action. Applied Agriculture in practically all lands now recognizes that the greatest source of loss to cultivated crops can be traced to the depredations of insect pests and plant diseases.'

LADIES AND GENTLEMEN, I have to finally thank you all for your patience in hearing my rambling views and suggestions. I am not quite sure whether the address was not a tedious infliction on at least some of you; if it were so I am indeed very sorry, but if I have succeeded in creating in my hearers at least some interest in a few of the insect problems of India I shall feel amply repaid and feel that I have not wasted your valuable time.

SECTION OF PHYSIOLOGY

President:—N. M. Basu, M.A.

Presidential Address

PHYSIOLOGICAL RESEARCH IN INDIA

Ladies and Gentlemen,

It is my first duty to thank you, especially my colleagues, for the signal honour you have done me by inviting me to preside over the section of Physiology this year. When a few months back this invitation reached me, I confess I at first felt diffident, being conscious of my personal limitations, in conducting the deliberations of this section after the most momentous and thrilling Jubilee Session of the last year, but I was genuinely glad as this would give me an opportunity, as it has done to-day, in placing before you, a most representative body of Physiologists and Biochemists in India, the question of activating the study and research in Physiology so as to bring its progress in line with such sciences as Physics and Chemistry.

Although this is the fourth year since the inception of this section, yet I am full of misgivings as to its successful career in years to come. When I was agitating in 1934 for the creation of this section, having been pained to learn at the last Bombay session of this Congress, that in the new Academy of Sciences to be started (the present National Institute of Sciences) there would be no place for Physiology, I was confronted with the most serious objection that the section, if created, would not continue on account of paucity of research in Physiology. On my approaching Dr. M. N. Saha for help, he suggested that the agitation would gain strength and vigour, if persisted through a society of Physiologists. This led me to agitate with the collaboration of my colleagues for the foundation of the Physiological Society of India in order that the society might render an immediate help in the creation of this section and would later on provide sufficient pabulum for the growth of this section by stimulating research work in Physiology in various ways throughout India and focussing the attention of the Government and the Universities for the expansion in different provinces of Physiological studies and research which are almost a *sine qua non* for the creation of a healthy and vigorous people in India and for banishing the various prejudices about health and diet and the influence of witchcraft in matters of health and disease, as they have affected even the most educated people of our country and are creating unconscious disaster amongst them. But unfortunately the society has failed to achieve all these objects. I, therefore, approach you in order that you may devise ways and means to accomplish them and I have, for this reason, chosen Physiological Research in India as the subject of my address.

SCOPE OF RESEARCH IN PHYSIOLOGY

The research in any scientific subject at the present age requires, besides a well-equipped laboratory, ample facilities for work and a band of well-trained and paid research workers. It would not be necessary for me to point out to you that before the establishment of the University College of Science in Calcutta and Institutions like the School of Tropical Medicines and the Institute of Hygiene and Public Health, the Conoor Institute, etc., the research in Physics and Chemistry and in various branches of medical sciences represented in these Institutions was more or less of an isolated character, having been initiated by some eminent individuals. The establishment of these Institutions has given an almost unbounded impetus to organized research work in various subjects represented therein, the consequence of which is evident from the pages of the 'Progress of Science in India during the past twenty-five years'. In the case of Physiology much leeway has got to be made up before it is placed in a position as respectable as that of Physics and Chemistry which stand unrivalled amongst the sciences in India. The teaching of Physiology in India is up till now confined mainly to the medical colleges where the professors are fully occupied with the routine work so that they do not, as a rule, get either leisure or facilities for systematic research work. I may reproduce in this connection some significant passages from a letter written to me by Dr. B. T. Krishnan of the Madras Medical College. He wrote thus: 'I am handicapped here by a meagre staff consisting of practically one Assistant and two Demonstrators (one of whom is temporary and replaceable every 2 or 3 years) to teach about 250 students of the 1st and 2nd year M.B. classes and about 100 students of the Health Inspector's Class....... You will realize that, under these circumstances, there is very little time and help for carrying out any research work, and the progress of any research undertaken must necessarily be very slow'. Major H. S. Anand of the Lahore Medical College made also a similar admission: 'There is no provision (financial) for the maintenance of research work in my laboratory and unless money is forthcoming a start cannot be made....... The Physiology Department in most colleges in India is mainly concerned in preparing students for their examinations'. This is practically the state of affairs in most of the Medical Colleges in India.* Further, when the execution of any scheme of research work is slow, as it must be when there is neither sufficient leisure, nor any research assistant, nor sufficient funds, not even any provision whatsoever for carrying out the work, it happens, more often than not, that the work along the same lines, and probably about the same scheme is published from laboratories where ample facilities exist, before the work is finished here. This gives a rude shock to the worker and discourages him in all future attempts.

Physiology is no doubt taught as an independent science in certain Universities in B.Sc. and M.Sc. courses, but the output of original work from them is negligible. This is due to a number of causes. First, Physiology being still looked upon as an inferior subject on account of the colossal ignorance of its tremendous advance in recent years and its vast potentialities, it does not get the requisite pabulum for its prosperous growth. The laboratory grant is generally miserable, bordering on ridiculous, insomuch that there is no spare fund for the purchase of various apparatus which are indispensable for any research work to be undertaken, the staff is generally meagre as in Medical Colleges and naturally, therefore, neither money nor help is available for carrying out any work. Secondly, students of Physiology having no material prospects before them after their educational career is over, this subject, in spite of its inherent necessity and importance in every day life, is not popular amongst the best students of any year. Accordingly students who take it up in their graduate and post-graduate courses, are, as a rule, not sufficiently well-equipped as to be able to contribute to the fund of knowledge in this subject. Thirdly, on account of the various factors which I cannot discuss here, most of these students do not either get opportunities, or are not encouraged, to take up Physics and Chemistry along with Physiology in their B.Sc. course. Consequently, their equipment in these basic sciences, a knowledge of which is not only highly essential but is being constantly utilized for the elucidation of the problems of Physiology, is so meagre that they can neither undertake investigations on their own initiative, nor can they be profitably employed in the conductance of research work. In fact, this subject is at present taken up in the graduate course by a class of so-called nondescript students, a large majority of whom having very poor attainments, do not cherish any aim in future, but are merely anxious to get a degree. They take all sorts of combinations without entertaining the idea of specialization in any of them. Fourthly, in spite of these difficulties, our earnest endeavours to train up boys in research work could not be continued merely because of absolute lack of encouragement from both the University and the Government.

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* But at King George's Medical College, Lucknow, the department of Physiology is fairly well-equipped, there being provision for researches by senior and junior Demonstrators as well. In consequence, a fairly large number of publications have appeared in the course of the last 10 years.

Fifthly, in some of these colleges the laboratories were built up in such a way, that no provision was even contemplated for research work by junior professors or demonstrators.* It is forgotten that the potential research worker is generally gradually made in the laboratory, he is seldom born as such. Fertility of mind is not so much an inborn quality of the mind itself as of the training and association which that mind has received. Sixthly, although Physiology has always been a handmaiden to medicine, yet it has been specialized independently of it to a surprisingly great extent in the course of the last 25 years owing to incessant application of modern methods of Physics and Chemistry in the elucidation of its problems. Naturally, therefore, a medical man who has got to acquire the innumerable improvements of modern therapy in 5 or 6 hectic years of forced mental feeding, cannot possibly be looked upon as an authority in Physiology, however eminent he might be in a particular branch of medicine, unless, of course, he has kept up with the march of progress in Physiology and is entirely devoted to it. If, therefore, Physiology is still kept in the leading strings of medical men, its growth would be hampered. This subject has developed to such an extent that it is given an independent position and is already a respectable science although it is not recognized to be so in this country due to ignorance of even our educated people. It requires exclusive attention of its votaries. Thus Physiologists are Physiologists irrespective of whether they are medical men or not. I cannot but reproduce in this connection the pregnant words of Prof. A. V. Hill, a Nobel Laureate in Physiology, in one of his letters to Col. S. L. Bhatia. 'A danger is that no man may be allowed to hold any place of importance in Physiology unless he has a medical degree. Avoid this tradition like poison.' This danger is a real one in India. If the Boards of Physiology consist of medical men who never specialized in the subject but whose knowledge of Physiology was acquired 20 or 30 or 40 years ago and from its applications in medicine, if Lecturers in Physiology are recruited from medical men who never specialized in this subject, on the off chance of their turning out to be Physiologists in course of time, the teaching of this subject and its growth are bound to suffer.

Lastly, the teaching of Physiology particularly in the graduate and post-graduate courses should be so adjusted and improved as to be able to supply a band of earnest and capable research workers to various Research Institutes, and well-equipped teachers to different seats of learning of Physiology, including medical colleges and schools. As I have already indicated a sound knowledge of the basic sciences, viz. Mathematics, Physics and Chemistry, particularly Physics and Chemistry, is necessary for the proper understanding of the various problems of Physiology and is highly essential for the undertaking of any important research work therein. In fact, the rapid advances in Physiology at the present time are largely caused by the contributions of bio-physicists and bio-chemists. Naturally, therefore, students who have not taken up either Physics or Chemistry as their auxiliary subjects in the B.Sc. course, should not be allowed to take up Physiology and those who would go in for honours and particularly M.Sc. in Physiology must have Chemistry at their B.Sc. stage and preferably also Physics. The practical work should also be made much more comprehensive than now and should include complete dissection of certain mammals and amphibia. The syllabus of Physiology in B.Sc. and M.Sc. should be more elastic, more comprehensive and should be in consonance with the modern development of the subject. The syllabus in our University in B.Sc. is too inelastic, too antediluvian, too vague and too inadequate. In such circumstances a teacher who devotes himself to teaching his students according to the modern development of the subject has no advantage over one who does practically nothing. Accordingly he loses his enthusiasm for the subject and the students suffer. If such students, in spite of their inadequate knowledge, are allowed to pass on account of this extremely inadequate and vague syllabus, people cannot but have a scant regard for the subject. This is one of the reasons why a very important and respectable subject, as Physiology is, has been relegated to an inferior position. At the M.Sc. stage, students must be encouraged to take up research work, for those who have not shown an aptitude for research must not be made future teachers. This subject cannot grow in respectability in our country without original contributions from its teachers. Also, a teacher who is not actively engaged in research work cannot possibly develop a passion for the subject. His teaching becomes monotonous in course of time and lacks that zeal which is so necessary to enthuse his students. Moreover, when a teacher devotes himself to investigations with his students, he comes in intimate contact with them, can point out to them the various lines of work and the ways and means of tackling systematically any problems that may arise. This is in my opinion far more important than reproducing text-books in advanced classes such as in M.Sc., when so many good text-books on Physiology are available and when the students who have acquired a sound knowledge at the B.Sc. stage, can easily master them. It is, thus, highly desirable that students are encouraged to take up research work at the M.Sc. stage and the regulations should be elastic and so adjusted as not to throw obstacles in their way.

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* The arrangement in King George's Medical College, Lucknow, is, however, an exception. The department of Physiology is so constructed as to give ample facilities to each member of the staff for carrying out original investigations.

This leads us to the question of the development of an organization for research in Physiology under the ægis of the Government or the Universities, in order that the teachers and the students may be engaged in investigations not only for the expansion of the bounds of knowledge, but also for qualifying the students for post-graduate degrees and making them eminently fit either as teachers or as investigators in future. A research organization of this nature is much more important for an admittedly backward science, as Physiology is in India, than mere multiplication of seats of learning, especially when it is not popular amongst the best students and its classes are manned by so-called non-descript students of whom mention has already been made. If such an organization is brought into being in every province, it will not only help in elevating the position of Physiology in India in near future, but also making it immensely popular amongst the students, as it should be.

I have discussed at some length the various reasons which are retarding the growth of Physiology in this country in the hope that an early attention of the Government and the Universities be arrested to this problem, and a central committee be formed to explore this question in all its bearings, such as, the framing of syllabus of Physiology in B.Sc. and M.Sc. courses, suggestions for the improvement of teaching and for the stimulation of research, etc. It is really refreshing to find that in spite of these disadvantages and obstacles physiological research is slowly making headway. It would not, therefore, be out of place if I mention some of the salient features in the researches carried out in recent times in India.

REVIEW OF PROGRESS OF PHYSIOLOGICAL RESEARCH IN INDIA

Blood

Napier [1] has shown that the Hb content of blood of Indians in Calcutta is, contrary to previous teaching, higher than in Europe. But it is curious that the iron and Cu content of blood of Indians in Calcutta show lower figures, for S. N. Ray and Ganguly [2] have found that Fe and Cu contents of blood of normal Bengalee subjects are 39·0 mg. and 0·14 mg. per 100 cc respectively, whereas the normal amounts of Fe and Cu in blood in Europe and America are 45 to 50 mg. per cent. for Fe, 0·1 to 0·5 mg. per cent. for Cu. Again, the higher Hb content of blood in Indians is not expected when malnutrition is so widespread amongst them. Thus, further work is required to have a true picture of Hb, Fe and Cu of blood. Sokhey et al's [3] work in ascertaining the physiological norms from a study of healthy young men and women of Bombay for r.b.c. in millions, Hb in g per 100 cc, cell volume in cc per 100 cc, Hb-coefficient in g per 100 cc, vol. coefft. in cc per 100 cc, color-index, volume index and saturation-index is worthy of note, as such figures would help the practising physicians in ascertaining the deviations from normal in different diseases. This work should be extended in various provinces in India (vide also *J. Am. Med. Ass.*, Vol. 108, 1937, p. 1686 for similar work in America). Mathur's[4] observation that the percentage of Hb in blood varies with outside temperature is interesting but requires confirmation. Dhar's[5] work on reticulocyte count, and Dharmendra and Rahman's[6] work on Arneth count should be taken up in all provinces. The determination of the total cell vol. of R.B.C. by the packed cell method with modifications suggested by Sokhey et al and of the mean cell diameter by Sankaran's[7] modified area method is interesting. The mean diameter of r.b.c. may be also easily and fairly-accurately measured with the help of a Filar micrometer.

I have studied in some detail the phenomenon of crenations of r.b.c. They are admitted to have an elastic envelope. When, therefore, crenations or creases are found on their surface, it may be assumed that the surface membrane has been modified. Crenations take place and persist if the corpuscles are suspended in isotonic, hypertonic or hypotonic saline. In hypertonic saline the cells at first shrink but after a prolonged stay some of them enlarge. This was also noticed by E. Ponder. In hypotonic solutions the cells enlarge at the beginning, but after a long time some of them shrink. If the corpuscles are suspended in Ringer's fluid, crenations are either absent or very slight. If they are suspended in modified Ringer's fluid in which the concentration of both Na and Ca is proportionately increased, they become immediately crenated and the surface of the cells thereafter shows very rapid changes in consequence of which the original shape is restored within a minute, but the cells become smaller and hæmolyse after some time. Thus, in this case these crenations precede the assumption of a smaller size. They also occur before the cells assume a larger size. In fact, on careful observation it is noticed that when the cells enlarge or shrink as in hypotonic or hypertonic NaCl solutions, the assumption of the final size of the cells takes place through several steps in each of which there are two phases, viz. a preliminary phase of crenation followed by the assumption of the normal shape but of enlarged or diminished size. In the case of modified Ringer's fluids, mentioned above, the preliminary crenation and the subsequent shrinkage take place very quickly. Thus the process of enlargement or shrinkage of a red corpuscle is different from that of an elastic ball, although there are evidences of the elasticity of its surface membrane.

If the corpuscles are suspended in modified Ringer's fluid in which the concentration of $CaCl_2$ alone is increased, they do not crenate, but a very small number of projections may be noticed on the surface. The cells shrink without being crenated and eventually hæmolyse.

An explanation of these diverse phenomena may be provided if it be assumed that the surface membrane of a red cell has a foam-like structure, like that of a colloidal gel, having elastic properties which a gel often possesses. It is known that this membrane consists of para-globulin, a small amount of nucleo-protein and lipide materials, lecithin and cholesterol. It is further assumed that the framework of this foam-like membrane is essentially constituted by these proteins, in the internal phase of which there is an emulsion of lecithin and cholesterol. If this be the essential structure of the surface membrane of these cells, two changes are likely to take place when they are suspended in a pure solution of NaCl. (1) The framework of this foam-like structure will tend to be solvated, as gels do in such circumstances[8] and (2) the lipides therein will be easily dispersed as was shown by Clowes.[9] In consequence of the 1st change, the elasticity of the gel structure will be modified and its permeability would be increased, particularly when the membrane is thinned by distension. On account of the 2nd change the passage of water, with the substances dissolved therein, from the cells to the suspension liquid and vice versa would be facilitated, for, if the lipide materials contained within the foam-like structure remains spread out in a thin and continuous layer, water cannot pass in or out through this membrane. When, therefore, these lipides are well dispersed, water can easily pass in or out.

If the cells are suspended in a solution in which Ca is in excess, the changes that are likely to take place are as follows:—

(*a*) the framework of the gel membrane will tend to be solidified and (*b*) the lipides within this membrane will tend to coalesce to form a continuous layer.

In consequence of the first change, the surface membrane will be more rigid and therefore less capable of distension or shrinkage. If, in such circumstances, the cells are made to shrink or swell, cracks are likely to take place on their surface-membrane, leading to liberation of hæmoglobin. The 2nd change will prevent the passage of water with the dissolved substances therein, the more the greater the coalescence of lipide materials within the membrane.

If the cells are suspended in a solution in which there is a balance between Ca and Na effects, as, for example, in Ringer's fluid, the normal elasticity of the membrane will be maintained and accordingly crenations of this membrane are not likely to take place.

In view of these considerations all the observed phenomena can be satisfactorily explained. When the cells are suspended in saline solution, owing to the changes mentioned before, viz., solvation and dispersion of the lipides, the elasticity of the membrane is reduced and permeability increases. Accordingly if there be any difference in tonicity between the corpuscular contents and the suspension medium, water will pass in or out, causing creases or crenations on the surface. The isotonic solution used was 0·85% NaCl solution. Very probably it was not exactly isotonic and accordingly slight crenations took place without any appreciable change in size. In hypotonic solutions water would easily pass in, and distend the cells. The permeability having been increased, the more on account of distension, salts would pass out causing outflow of water and therefore, shrinkage. This was also actually found to happen, for Ponder and Robison[10] have shown that *K* escapes from rabbits' r.b.c. when placed in hypotonic solutions. In hypertonic solutions water would pass out causing shrinkage. But if the cells are kept for a long time in such solutions, the permeability of the membrane having increased, salts would gradually pass in, causing inflow of water and therefore, distension. This also actually took place. In Ringer's solution, as predicted by the theory, crenations do not, as a rule, take place. In modified Ringer's fluid with an increase in Ca concentration, hæmolysis actually took place as mentioned before. The membrane having become stiff, creases or crenations are not possible and were not also observed.

Cardio-vascular System

Dr. Gupta's work[11] on the comparative efficiency of anæsthetics and decerebration at the usual plane in cutting off all the influences from the cerebrum and other higher centres for the study of cardio-vascular problems unaffected by these influences and his further work[12] disproving the theory of Eppinger and Hess that there is a balance between vagotonia and sympathotonia in normal animals are worthy of note. Dr. Cruickshank's work[13] on the physiology of coronary circulation and the methods adopted by him in its study deserve more than a passing notice. The technique of these methods should be adopted in similar studies in this country. Dr. Burridge's researches on the perfused heart of frogs and his masterly analysis of the experimental results led him finally to expound a theory of rhythmical activity of the central nervous system and sensory organs, the former of which has been substantially confirmed by the brilliant investigations of Adrian.

With regard to perfusion of frog's heart it has been possible for me to evolve a technique which gives very consistent results, if the *p*H of the perfusion fluid and its temperature are kept fairly constant. The perfusion fluid (Ringer prepared according to Bayliss's formula) is made to flow from a reservoir into a small and narrow cylindrical tube drawn out at the bottom and fitted up with a side-tube (bent downwards at its end) just one inch from the bottom as given in Harris's Experimental Physiology.[14] The liquid from this tube is then introduced through a fine rubber tube and a cannula into the inferior vena cava, the cannula being tied in such a way that the ligature is applied beyond the sino-auricular junction. Then, of the two branches of the aorta, one is tied and an incision is made into the other through which perfusion fluid flows out. As the proper beating of the heart depends upon distension (Starling's law of the heart), it is necessary that the heart is kept properly distended. This can be done either by raising the pressure, i.e. by raising the cylindrical tube or by introducing a resistance through the incision into the aorta. A fine tube bent twice at right angles and drawn out at both ends serves very well for a resistance. One end of this tube is introduced through the incision into the aorta. The heart beat improves immediately after the introduction of this resistance and keeps steady. With this technique one can very satisfactorily investigate the action of drugs on frog's heart and the effects of small variations in the concentration of the drug.

Dr. B. Narayana's work on the action of drugs on coronary vessels may help in combating cases of sudden death due to coronary insufficiency. His work also on the action of drugs on perfused lungs deserves mention. Chopra, Das and Mukherjee's work[15] on the effects of drugs on embryonic heart explants has opened up a new and very interesting field of research in India.

Respiration.—Bhatia, Krishnan, Reddy and Subba Rao's work in Bombay, Madras, Vizagapatam and Mysore respectively in estimating the normal standards of vital capacity and their relationship to body surface area and standing height should be extended to other provinces as well.

ALIMENTATION AND METABOLISM

The analysis of normal gastric juice, both resting juice and the juice secreted at different intervals after a testmeal, has rightly attracted the attention of a number of workers, such as M. Narasimha Rao in Madras, Bhatia et al at Bombay, Gupta and Sen, Ghosh, and Napier at Calcutta, for establishing physiological standards in this country. It is curious that both Rao and Napier found that contrary to expectations the maximum acidity is higher than Bennet and Ryle's figures. Rao further found that the motility of stomach is greater and therefore the emptying time is less (but according to Ghosh the emptying time is greater) and the pepsin content higher than Bennet and Ryle's figures.

The digestibility of some of the edible oils and fats has been studied by Dastur and Giri.[16] The digestibility of all the edible oils may be profitably ascertained. In studying the digestibility of various foodstuffs by proper ferments it is worth while remembering that in the alimentary canal there may be an interdependence of digestion of these substances. H. K. Sen et al have brought out this important point by demonstrating the influence of various amino-acids on the diastatic digestion of amyloses. Thus the in-vitro digestibility of a substance by a ferment may not give the true picture of its digestibility in the body. Basu and Mukherjee's work[17] dealing with the digestibility of proteins and starch of different varieties of rice and pulses is highly interesting and useful. Kamala Bhagvat[18] has drawn attention to the higher digestibilities of globulins when subjected to successive actions of pepsin and trypsin than to trypsin alone, and has rightly emphasized the importance of maintaining strictly the in-vivo sequence of action, in the course of in-vitro studies, if the true digestibility of any foodstuff is to be evaluated. She has further investigated the availability of the amino-acids, in contrast to the total quantity present in certain globulins. The digestibility of proteins of different varieties of fish should be investigated without further delay.

Krishnan's work about the nature of movements of bowels and dependence of the rhythmicity of intestinal muscle upon enteric nerve cells and fibres deserves special mention. His further work on uniform stimulation of the different parts of the small intestine by histamine and acetyl-choline is interesting.

Mukherjee's work[19] showing that choline cannot prevent the fatty infiltration of liver in rats caused by anterior pituitary extract is of considerable note and use. Basu and Basak[20] have shown that the heart tissue of rats may cause a very slow rate of oxidative de-amination of certain amino-acids. Its significance has not been discussed. Does it provide a further proof that these amino-acids are not generally utilized for the normal functioning of the heart?

The basal metabolic rate of Indians in different parts of this country has been studied. This is of utmost importance in connection with nutritional problems of this country. The results of investigation of all the workers show a definitely lower value amongst Indians than Harris-Benedict or Aub-Du-Bois standards. According to Rahman there is no marked seasonal variation in basal metabolism, but the B.M.R. is, curiously enough, slightly higher during summer (2·5% higher) than during winter.

DIETETICS AND NUTRITION

There has been a fairly comprehensive work about dietetics and nutrition in the course of the last few years on account of a liberal supply of grants from the Indian Research Fund Association. The work comprises nutrition surveys, diet surveys in various areas, investigation of the effects of supplementing deficient diets by important dietary essentials found lacking, determination of the basal metabolic rate in different parts of the country, measurements of A.C.H. index in certain places, determination of pelidisi of Pirquet, analysis of a large number of foods for their content of proteins, fats, carbohydrates and important minerals and determination of various changes in chemical compositions of these foods during cooking, assay of vitamins A and carotene, B_1, B_2, B_6 and C in different foods including fruits and vegetables, determination of available Ca, P, Fe and of oxalic acid in foods, investigation of the effects of balanced diets on rats and groups of individuals, comparison of the efficiency of diets prevalent in different parts of India by the balance-sheet method and rat growth tests, and determination of the digestibility, biological value and essential amino-acid content of proteins of different cereals, pulses and some varieties of fish. Further, the determination of sub-optimal nutritional deficiency of boys with regard to various vitamins has also been undertaken. With the progress of these studies, the evolution of proper and cheap diet menus becomes more and more feasible. It would not, therefore, be out of place to mention the important results of these investigations.

Aykroyd et al[21] investigated the state of nutrition of over 1,900 boys between 6 and 15 years and found that Indian children of a given height weigh very much less than British and American children of the same height, that an appreciable number of these boys suffer from various food-deficiency diseases and that climate has no advantage as regards physique and state of nutrition. They made a diet survey of 44 families in South Indian villages at different seasons and found that children in families having an annual income varying from Rs. 50 to Rs. 100 are suffering from various deficiency diseases and have a tendency towards œdema. Their height and weight averages are much lower than normal and they are living perpetually on a diet of lower caloric value than the minimum. In consequence they are lethargic and have a low vitality and their output of work is small. Further, as Cowell[22] has pointed out, dietary deficiencies in early life may lead to imperfections in the growth of the tissues which cannot be repaired in later life by the most perfect diet.

They also carried out diet surveys in South India in 24 hostels and found that their diets, although of low nutritive value, are superior to those of the people in general and accordingly their weight for a given height is greater than that of children of the same class in the general population. Food-deficiency diseases are common amongst the boarders. These are reduced considerably by the addition of milk, liver or fresh vegetables in sufficient amount. Some improvement can also be made by substituting millet to a large extent in place of milled rice, and adding cheap leafy vegetables and cheap butter-milk or skim milk to their diet. They further noticed that the daily addition of 1 oz. of skim milk powder to typical Indian diets caused a general increase in height and weight, a general improvement in health and disappearance or partial cure of various deficiency diseases. They also showed by carrying out experiments on rats that the effect of skimmed milk on the enhancement of growth, etc. is almost solely due to its Ca content and some heat-stable factor in vitamin B_2 complex, possibly vitamin B_6. It is to be remembered that the addition of 1 oz. of dry skim milk is equivalent to the addition of nearly 12 ozs. of milk without fat to the daily ration.* It is curious that the effect of the addition of 12 ozs. or 1½ poa of skim milk to the daily ration is almost entirely due to its Ca and vitamin B_6 (?) content and not to two proteins of very high quality, viz., lactalbumin and caseinogen (vide Basu and Swaminathan's work on the biological value of proteins, mentioned later on). These results, therefore, require confirmation. Further, the effect of daily addition of 1½ poa (12 ozs.) of milk to typical Indian diets should be contrasted with that of the addition of 1 oz. of skim milk powder, for the total cost of the former would be less than that of the latter (the daily addition of 1½ poa of milk corresponds to the monthly requirement of about 11 srs. of milk, the cost of which, according to Calcutta rates which are very high, is Rs. 2-8 as against Rs. 3 for skim milk, if 1 oz. of skim milk powder be daily added).

A point of great importance is that while these workers planned a series of cheap well-balanced diets at the cost of Rs. 4 or Rs. 5 per month per adult, they felt it difficult to devise a thoroughly satisfactory diet of which milled rice is the main ingredient, at a low cost of Rs. 5 per month. They were, therefore, constrained to remark, 'we must view with alarm any extension of mechanical rice-milling in rural areas'. Wilson et al carried out a nutritional survey of 3,000 boys of different communities in Calcutta and 1,250 boys in the Punjab by A.C.H. index (i.e. by arm, chest and hip measurements) and concluded that Franzer and Palmer's figures for this index are not applicable in India. He could not detect any deficiency disease in both places although carious teeth and enlarged tonsils are prevalent and may be correlated with the economic status. Aykroyd et al[23] made again a nutritional survey of 4,646 school children in South India by A.C.H. index and recorded simultaneously the incidence of signs of deficiency disease. The A.C.H. index was intended by its authors, Franzer and Palmer of the American Child Health Association 'to be an aid in sorting out children who should be seen by the Physician. According to these authors this index selects out children with small amounts of musculature and fatty tissue relative to body-build.

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* Cow's milk contains nearly 88% water and 12% solids including fat. Accordingly in skim milk, fat, of which the percentage content is nearly 4, being absent, the ratio of solids to water would be nearly to 8 : 92. Hence 1 oz. of dry skim milk is nearly equivalent to 12 ozs. of milk without fat, which in terms of indigenous measurements is equivalent to 1½ poa of milk.

The investigations of Aykroyd and others led them to conclude: (1) that this A.C.H. system is based on an increased antero-posterior diameter of the chest, and (2) that, of the 23·8% selected by this index, 15·9% showed clinical signs of malnutrition. In other words, the index selected 76·7% of those who showed clinical signs and only 13·9% of those not showing any clinical signs. Further, mean values of G (i.e. the sum of measurements of the circumference of the right arm at the highest point of the biceps with the forearm hanging down and with the tips of fingers touching the shoulders minus the sum of measurements of the antero-posterior diameters of the chest at the nipple during inspiration and expiration, for a known hip width from trochanter to trochanter) were found to be lower at all ages in the affected groups. Sixty per cent. of affected children showed negative values of G as compared with 5% of free children.

The authors, therefore, recommended this index as a supplementary method of assessing malnutrition in South India. In fact, a rough and ready method like this should be of considerable help in detecting the extent of malnutrition amongst the vast population of India.

Wilson et al carried out diet surveys in several middle-class Bengalee families and found that their diet is deficient in animal protein, animal fat, dairy products and Ca. Further, a large percentage of the total caloric intake, nearly 80%, is derived from cereals. In U.S.A. Rose recommends that for children, not more than 24 to 37% of the total caloric intake should be derived from cereals. For adults a somewhat less milk and more cereals may do. These authors again carried out a diet and physique survey in Assam, rural Bengal and Calcutta and found that although Assam boys were getting 1,000 Y per consumption unit of carotene plus vitamin A, i.e. about 30 Y per Kg of body weight, yet an appreciable percentage were suffering from vitamin A deficiency diseases. They further noticed, contrary to their previous finding, that the incidence of caries is greatest amongst the well-to-do and least amongst the poor Assam coolies. Similarly, the incidence of enlarged tonsils has a negative correlation with the poverty of diet.

Niyogi et al evolved a physiologically ideal diet at Bombay costing Rs. 10 per month per head, which produced a maximum increase in weight in rats and normal procreation as compared with balanced diets and routine diets. They considered this to be due to high animal fat, animal protein and lysine content and also to fresh whole milk.

McCorrison showed that rats fed on sikh diet grow best and do not suffer from pulmonary and gastro-intestinal troubles, whereas those on Madrassi diet have stunted growth and suffer from these troubles. The sikh diet consists mainly of whole wheat, plenty of milk, leafy vegetables and fruits and occasionally meat.

According to McCorrison, although nutrition is adversely affected by imperfect oxygenation, insufficient rest, want of sleep and proper exercise, overwork and fatigue, the greatest single factor is perfectly constituted food.

Ranganathan et al have done a very useful work in analysing edible portions of 200 common foods, including cereals, pulses, leafy, root and other vegetables, nuts and oil-seeds, condiments and spices, flesh foods, etc. They found that in cereals Fe and P are comparatively larger in amount than Ca but in leafy vegetables, Ca content is rather higher than P. This shows the advantage of supplementing a largely cereal diet by vegetables. Condiments and spices are found to be good sources of Fe but its availability is low, and some of them are also rich in Ca and P. Amaranth and Drumstick leaves are rich in proteins, Ca, P and Fe. In studying losses in some of these foods during cooking they found that there is not much loss in proteins and fats of cereals and pulses during boiling, although there is an appreciable loss in minerals and carbohydrates, esp. when the boiled water is rejected as in the case of rice. In the case of rice, Fe and P are considerably removed during washing before cooking and 10% or more of carbohydrate is lost in the conjee.

Basu [24] and Ranganathan [25] have separately determined the available Fe content of a large number of common foods. This is of utmost importance in the preparation of diet charts. There has been a very wide discrepancy in the results in certain cases. For example, spinach, according to Basu, contains 2·42 mg. per cent. of available Fe, but according to the other worker 0·93%. Again, Bengal gram, according to the former contains 5·84 mg. per cent. but according to the latter only 1·56 mg. per cent. and so on. Are these wide variations due to differences in the soil in which these foods have grown or due to differences in methods?

It is of interest to note in this connection that Hahn and Whipple [26] have shown that, in experimental anæmia in dogs, available Fe, as measured by the di-pyridyl method, has no physiological significance. An Fe salt, 100% available by di-pyridyl test was found to be only 35% physiologically available. Again fractions of heart, liver, spleen and kidney may contain but little Fe, yet cause much regeneration of Hb in anæmic dogs. Further, Okada et al [27] have shown that an extract of spinach stimulates gastric secretion and hæmopoiesis to such an extent that the efficiency of stomach and liver therapy in pernicious anæmia can be much improved by combining it with spinach extract.

Sundararajan and Giri have separately determined the available P in various foods by estimating the total P and Phytin P in them. They found that cereals contain a high percentage of Phytin P (i.e. unavailable P), whereas green and leafy vegetables contain a negligible amount; the content of Phytin in pulses, condiments and spices is intermediate between cereals and vegetables. Giri has also determined the Phytin activity of various foods, for the availability of Phytin P of foods depends on their Phytase activity and also on the Phytase content of the alimentary canal of animals.

It is worthy of note in this connection that although low P rickets can be easily produced in rats and puppies by a diet of cereals, it is unknown in man, for phytin-phosphatase is definitely present in the alimentary canal of human beings.[28]

The determination of the availability of Ca in foods is rather complicated, for it depends on a number of factors, such as, (1) the form in which it occurs in foods, viz., organic or inorganic form, for without a conversion of organic into inorganic form absorption does not take place, (2) the presence of oxalic acid or oxalates, P or fat in foods, all these reducing the absorption of Ca from the upper regions of the small intestine, (3) the *p*H of the intestinal contents, for at higher *p*H Ca-salts are insoluble but are soluble at a lower *p*H, and (4) the presence of sugars, particularly lactose, which yield organic acids and therefore lower the *p*H in the intestine.

Mazumdar and De have estimated the oxalic acid content of foods and have shown that foods rich in oxalic acid do not favour Ca absorption. Rice, amongst the various cereals, having the lowest oxalic acid content, Ca absorption with rice is maximum.

Leitch[29] has shown that although cow's milk contain nearly 4 times the amount of Ca present in breast milk, infants fed on cow's milk are more liable to develop rickets than breast-fed infants, for the buffering power of cow's milk is so high that it requires a much higher degree of gastric acidity than does breast milk to ensure diffusibility of Ca in the intestine. Roe[30] has shown that milk is an undesirable vehicle for the administration of Ca-salts which should be given with water or fruit juices from ½ to 1 hr. before meals. He has further shown that Ca and P should not be given as Ca-phosphate and as regards P, if the diet contains sufficient phospho-proteins and phospholipins as to bring about an excretion in the urine of from 1 to 3 g of phosphate as P_2O_5 per 24 hrs., there is no necessity of adding further P in any other form.

K. P. Basu and Swaminathan have separately investigated the biological value of the proteins of various cereals, pulses and fishes which are used largely in our country and have also determined the supplementary relations of various mixtures of foods which are commonly used in India. That rice proteins have a very high biological value was known and has been confirmed by them, but their investigations have revealed that Bengal gram or green gram or black gram are much superior to lentils and that although pulses are, as a rule, of lower biological value, rice and pulses or ragi and pulses form very good supplementary relations and that their power of supporting growth is enhanced by the addition of a small amount of animal protein, large amounts of the latter being not required for this purpose. (Compare the effect of addition of 1 oz. of skim milk powder by Aykroyd et al.) Basu has shown that ruhee fish proteins have a higher b.v. and greater digestibility than those of hilsa and that sun-dried fish is always superior to steam dried fish regarding digestibility and b.v. He has also shown that the ruhee fish liver oil has a much higher vitamin A potency than that of hilsa and that whereas the vitamin A potency of body-oil of ruhee is 109 Y, that of hilsa is nil. Basu has further determined the amino-acid make-up of the proteins of various kinds of rice, pulses and fish.

Vitamins.—Guha, Ahmad, De, Wilson, Giri, Rudra, Ranganathan, Srinivasan and a host of other workers have studied the vitamins from various aspects. Guha first showed that besides oranges and lemons there is a large number of local fruits which are rich in vitamin C and some of them are even richer in this vitamin than oranges and lemons, e.g. Lichis, mangoes and guava. Pine-apple and amla are also very rich in this vitamin. Rudra found that this vitamin is more concentrated in the skin of fruits and vegetables than in the inner edible portion. Ranganathan showed that green leafy vegetables lose this vitamin readily on storage, the loss being quicker at higher temperatures, but fruits hardly lose this Vitamin on storage so long they remained green, but after ripening an appreciable loss takes place. Rudra has shown that quick frying in oil or ghee or partial frying and then boiling do not reduce the vitamin C content of liver, cauliflower or spinach to a great extent. Giri has shown that the presence of Glutathione and pyrophosphate in tissues and plants is at least partly responsible for the protection of vitamin C in them from oxidation. Giri has further shown that pyrophosphate of Na protects the oxidation of vitamin C even at PH-7·2 and has evolved a method of extraction of this vitamin from substances by the addition of this pyrophosphate to CCl_3COOH. We have not succeeded in protecting this vitamin from oxidation when it is added to Ringer's solution or Fleisch's solution at PH-7·6. Guha has succeeded in extracting with $CHCl_3$ a substance from cabbage, which he termed ascorbigen, and which, on boiling in the absence of O_2, is converted into ascorbic acid. This substance sometimes occurs in urine. Whether this substance has any relationship to vitamin C metabolism is not yet known. We have found its excretion in urine to be erratic and bears no apparent relationship to the amount of this substance in food taken.

The importance of vitamin C in infections has been amply borne out by the following observations:—(*a*) a deficient guinea-pig is less resistent to infection, (*b*) respiratory infections are common when fruits or vegetables are not available, (*c*) in cases of pulmonary tuberculosis the severity of the disease runs parallel with the degree of unsaturation, (*d*) in rheumatic fever a deficiency of vitamin C may be an important aetiological factor, and (*e*) that this vitamin has an inactivating effect on diphtheria and tetanus toxins in vitro.

Vitamin A and carotene.—Much useful information regarding practical dietetics has been obtained by the researches of Ahmad et al and particularly of N. K. De about carotene and vitamin A in foods. Leafy vegetables are, as a rule, rich sources of carotene which is lost readily on storage, as in the case of vitamin C, but not on boiling. The loss during storage can be prevented, if after being moistened, they are wrapped up in moist cloth or green banana leaves. Of the non-leafy vegetables, viz., roots and pulses, etc. soya bean, lentils, green gram, Bengal gram are good sources of carotene which is lost readily on boiling. Of the fruits, ripe ones, such as mangoes, oranges, tomatoes and papaya, are richer than green ones and they do not lose their carotene readily on storage. The potency of carotene or vitamin A in canned foods remains undiminished. Like vitamin C, the carotene content of outer green leaves of cabbage or the skin of oranges or limes is greater than in the inner portions. Vegetable products contain only carotene and not vitamin A, but both carotene and vitamin A may occur in animal materials. As regards the absorption of carotene, it was found by N. K. De that it is not completely absorbed even at the level of 1 Y intake per day. It is better utilized when fed in oil solutions than from natural foods, and the fat content of a diet, from 0 to 40%, does not affect the absorption of vitamin A and carotene. But according to Wilson and Ahmad, the percentage of absorption on a fat diet is about 90 in contrast to about 50 on a similar diet without fat. Wilson, Ahmad and Mazumdar have shown that the liver of rabbits can transform carotene into vitamin A.

Vitamin B complex.—Wilson et al have shown that (1) vegetables are poor sources of vitamin B_1, (2) pulses are rich in this vitamin, the amount varying from 115 to 190 I.U. per 100 grams and arhar containing the largest amount, (3) beans, peas and barley are also very rich in this vitamin, containing 150 I.U.%, and (4) that while wheat contains 100 to 110 I.U., polished rice contains only 26 I.U.%.

Wilson and Roy have shown that pulses and then leafy vegetables are good sources of, but fruits are poor in, flavine and that vitamin B_6 has also the same relative distribution. Narasinhamurtty has shown that pepper is rich in flavine.

Vitamin B_1 plays a very important rôle in our body. It has been definitely established that this vitamin, after phosphorylation in the body, acts either as a co-carboxylase, profoundly influencing the course of oxidation of carbohydrates, or as a co-oxidase, catalyzing the oxidations in general in the body, or both. Naturally, therefore, the intake of vitamin B_1 by our countrymen, whose diet consists principally of carbohydrates, is of great consequence.

In view, therefore, of the great importance of vitamins B_1 and C, as mentioned previously, and also of A, as mentioned later on in connection with the rôle of the latter in resisting infection to tuberculosis, we have undertaken a survey under the Indian Research Fund Association of the state of saturation of Bengalee boys with regard to vitamins B_1 and C, and we have proposed to do the same with regard to vitamin A also. We have already found that Bengalee boys, both Hindu and Mahomedan, belonging to middle-class families and reading in colleges, are, as a rule, in a high degree of unsaturation with regard to vitamin C and that the urinary output of this vitamin in a person bears no relationship to the state of saturation of his body, provided it is not higher than 50 mgms. per day. Considering the importance of this vitamin, we tried to ascertain its minimum requirements in our country for keeping the body at the lower level of saturation and found that it is about 50 mgms. per day as against 25 mgms. required by the people of Europe and America. The vitamin B_1 enquiry is also in progress and it is still too premature to mention anything about its minimum requirement in this country. According to Cowgill the minimum requirement of this vitamin to protect a person from beri-beri is 150 to 350 I.U. per day. The largest sources of vitamin B_1 in our foods are the various dals (pulses). This, therefore, establishes the importance of 'dal', or rather 'dal soup' in our dietary.

Aykroyd and Krishnan could detect a number of deficiency diseases prevalent in South India, such as (1) angular stomalitis combined with sore mouth, cured by vitamin B_2 complex of dried, autoclaved yeast, (2) Keratomalacia including eye symptoms, cured by cod-liver oil or red-palm oil which is very rich in carotene, and (3) phrynoderma, due to lack of protective foods.

The extensive researches in dietetics have established the importance of rice (parboiled and unpolished), dal and vegetable diet in tropics. Although rice has a low content of protein, its protein is of high biological value. Of all the cereals, rice helps the maximum retention of Ca and Mg (Mazumdar and De). Rice and dal (particularly green gram) exhibit supplementary relations with regard to growth (K. P. Basu). Rice and vegetables would maintain the Ca and P ratio (Ranganathan et al). With rice diet there is less risk of suffering from urinary calculi than with wheat (Wilson). The low protein and vitamin B_1 content of rice are made good by the high protein and vitamin B_1 content of pulses. Further, the protein value, biological value and digestibility coefficient of green gram amongst the pulses are pretty high. They are respectively 10·5 as against 15 of whole egg, 62 as against 85 of milk and 86 as against 90 of beef liver (Basu and Swaminathan). Further, rats on green gram ration containing 15% protein grow almost as efficiently as on a diet of milk and whole wheat. Zuntz et al have shown that a high carbohydrate diet, such as, a daily rice diet, involves a considerable retention of water or, rather, creates a reservoir of water for evaporation and urine formation. Moreover, while carbohydrates are metabolized and they are metabolized more readily than others, mobile fluid is rendered available. Again, pulmonary ventilation is greater when carbohydrate, rather than fat, is burnt owing to a larger output of CO_2 per calorie of heat. This would increase heat loss by evaporation of water from the lungs. They, therefore, concluded that in a hot climate a high carbohydrate, rather than a high fat, diet is necessary to meet the demands for fluid for warding off the effects of heat by sensible and insensible perspiration.

Before I conclude this summary of nutrition and dietetics I may quote the following from an address of Col. McCorrison, illustrating the importance of nutrition in resisting the infection to tuberculosis:—

'Adequate nutrition resists infection to tuberculosis, for at the Papworth village Settlement no child, born during 20 years of its existence, has contracted tuberculosis of any form, although they are the offspring of parents who suffer from tuberculosis and are in constant contact with them. Vitamin A is the most important element in nutrition which resists infection of respiratory tract'.

Further, in discussing the relationship between diet and the normal functions of the different parts of the body or diseases relating to Obstetrics and Gynæcology, Neurology, Ophthalmology, Dermatology, Laryngology, Respiratory tract, etc., Col. McCorrison made the following significant remark in a meeting of the British Medical Association: 'Let us teach the student less about disease and drugs, and more about health and nutrition which is the very basis of health'.

The physiological truths about nutrition and dietetics, revealed by these researches would not be of much use unless the necessary food and service are available at a price to suit the incomes of average people and their conditions of life.

Nervous System.—Electroencephalographic studies have been taken up by N. N. Das under the able guidance of Col. Chopra and it is expected that results of immense interest would be obtained. Bagchi[31] in investigating the adaptation of variability of response of the human brain rhythm has found that a definite claim on attention or a definite activation of an existing psychophysiological pattern was an important factor, esp. in the case of sound stimulus, not only in depressing the waves but in determining the length of adaptation time and that the brain is able to regain, more or less, the potency of its dynamic rhythm in the face of continuous and repetitive stimulus attack.

CONCLUDING REMARKS

In reviewing these researches one cannot but be struck by the very extensive investigations about practical dietetics. Such rapid strides were possible partly on account of funds supplied by the Indian Research Fund Association and partly because of the existence of such research organizations, as the Nutrition Institute at Conoor, Bangalore Institute of Sciences and the Institute of Public Health and Hygiene at Calcutta. If other branches of Physiology are to march forward it is indispensable that there is also a central organization for research and there should be sufficient funds for research workers. Further, if Physiology is to grow properly it must not be in the leading strings of medicine and medical men, for it has already become a subject 'worthy of regard as an independent scientific discipline'. To quote Sir Frederick Gowland Hopkins, 'medicine has been the foster-parent of biological sciences and can, therefore, claim their loyalty, but medicine has sometimes kept them too long in bondage, not always realizing their capacity for independent growth'. This is nowhere more true than in India and the effect has been most miserable. To-day Physiology is regarded with contempt by the administrators, teachers of other sciences, students and laymen, in spite of its inherent greatness as a science and its unquestioned importance in social services. The teachers of Physiology are no less to blame for this pitiable condition. They have unconsciously accepted for it an inferior position in the chessboard of medical and other sciences, forgetting the marvellous development and many-sided growth of this science in recent years on account of indefatigable labours of a galaxy of biochemists, physiologists and pharmacologists. The physicists too are not slow in helping Physiology in the solution of its problems. The work of Hevesy and Lundsgaard [32] in exploring the site of synthesis of lecithin following administration of fat, of Hahn and Hevesy [33] in ascertaining the origin of yolk of lecithin and of Hevesy and Aten [34] in determining, after the administration of soluble inorganic phosphates, the rate of formation of the various phosphorus-containing constituents of milk with the help of labelled phosphorus, has opened up a new vista of possibilities in the solution of intricate physiological problems. In an article in the Physiological Reviews [35] it has been well brought out how physicists interested in telephone and radio reproduction of speech, psychologists interested in the sensation of hearing, experimental phoneticians studying the elements of language, and clinicians examining disorders of speech and hearing are all obtaining information of interest to the physiologist and helping him in elucidating the mechanisms of hearing and speech. All these point to the urgent necessity of the establishment of a central organization for research in Physiology. As Physiology and Pharmacology are very closely allied to one another and in fact, as Col. Chopra stated, one is inseparable from the other, may I not plead with the authorities to consider the establishment of this organization for Physiological Research by the side of that of Pharmacology which will be established in near future under that renowned Pharmacologist in India, Bt.-Col. R. N. Chopra ? An advancement in the knowledge of Physiology will place Pharmacology on a firmer basis, so that Physiology cannot lag behind while Pharmacology will go ahead. Physiology and Pharmacology, marching ahead side by side and tackling the many intricate problems of health and amelioration of disease, will usher in a new era of happiness to the suffering millions of our country. If such an organization materializes in near future, as it must, and if it be placed in charge of men who are actually engaged in expanding the bounds of knowledge of Physiology, the position of Physiology in India will be altered in the near future. It will be as 'intellectually respectable as Physics, Mathematics and Chemistry and men of really first-class ability will be attracted to it'.

Let us, therefore, all combine to fulfill our mission of serving Physiology with an unbounded faith in us and making it a living science in India so that it may contribute a noble and worthy part in the national regeneration of this country.

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SECTION OF PSYCHOLOGY

President:—H. P. Maiti, M.A.

Presidential Address

DYNAMIC STRUCTURE OF THE HUMAN PERSONALITY

It is not because of its popularity but because of its growing importance in recent years that I have chosen the problem of personality as the subject of my discourse here. Any student of the history of Psychology in the 20th century must have noticed how this problem has been steadily coming into the forefront of contemporary theory and research. We now feel an urgent need for understanding the individual as a whole both in his conscious and unconscious reactions. The need is not only a theoretical one but also a practical one of very great importance. Modern Psychology has had a definite call to help the individual and the society in the work of mutual adjustment and thereby to add to the total human happiness and efficiency. The problem of personality in its practical aspects meets us today wherever we have to deal with human nature in the concrete—in hospitals and clinics, in child guidance and vocational guidance centres, in factories and stores, in schools and colleges.

I. Critical review.

Beginning of Scientific Psychology and problem of Personality.

There has always been popular interest in the subject of personality. Until recent years, however, scientific Psychology did not attach much importance to it. From the very beginning it had a fear of the complex problem, and chose to work from elements up. This plan of work was adopted from Chemistry which was taken as a model for the new science of Psychology. The plan had, of course, its advantages and led us far on the path of scientific progress, but it soon appeared that in spite of its clear-cut scientific exactness, it had very little chance of helping us to understand the concrete individual in whom society must always be mostly interested. Clamour for a changed outlook registered itself very soon in the form of new movements. In Functionalism the felt need for viewing the individual organism in its concrete biological setting and of describing its natural reactions to this setting had its direct expression, but beyond giving us a general biological orientation it could not achieve much by way of a real psychological explanation of the personality as a whole. Behaviourism which followed this movement laid sufficient stress on the 'organism at work', and attempted an analysis of factors of personality. One has to deplore, however, the behaviourist's refusal to take into account the conscious aspect of the mind. Moreover, the general plan of personality structure is regarded by him as an additive one. He, at any rate, brought the problem of personality into prominence and had a considerable part in initiating tests of personality traits.

Psychiatry and problem of personality.

While towards the close of the last century scientific Psychology of the laboratory was fighting shy of the complex problem of personality, it did not fail to engage the attention of a number of psychiatrists, notable among whom are Pierre Janet in France and Morton Prince in America. Working with the hypnotic method they familiarized us with the phenomena of dissociation of personality. Personality, as a wider term than mind, was meant to include much outside our consciousness. On the basis of a supposition of different levels of integration, which Janet described as 'psychic tension', he distinguished two main types of personality structure, namely, psychasthenic and hysteric. Janet's work became very fruitful for psychiatric practice and theory, but from the systematic point of view, we shall have to say, his real standpoint was more physiological than psychological. Ultimately speaking, the integration of personality is, according to him, a nervous matter. His conception of mind is a mechanistic one, and he was very much influenced by the associationistic psychology.

The investigation of psychiatrists on personality has been very valuable in introducing into general Psychology a concept which can take the place of the old metaphysical concept of self. It indicated also that the unity within our mind is not given from the very beginning, but has to be gradually built up in the process of development and maintained with difficulty through stress and strain of adaptation to varied circumstances of life. It revealed also that the unity within the human mind is seldom perfect. The psychiatric school, however, cannot be given the credit for having disclosed to us the mechanism of personality integration. It has not given us any insight into the way in which out of separate elements a unitary structure slowly emerges and in which that structure manages to preserve its integration throughout life in spite of onslaughts from changed circumstances.

Personality Tests.

If scientific Psychology failed to appreciate the importance of the problem of personality in its earlier stages, it has made sufficient amends in recent years in the form of a vigorous movement of Personality testing. A huge amount of experimenting is going on at present on this subject, specially in America and Germany, and we are looking forward to developing tests by which it would be possible for us to determine the personality type of a man or to predict the general character development of a child, in the same way as we have been doing in the intellectual field with the help of Intelligence tests. It must be noted that the recent enthusiasm in Personality testing has been inspired by practical needs rather than by any systematic consideration within the science of Psychology. The technical help of psychologists is now being increasingly demanded to understand and advise upon psychological difficulties of a large number of individuals.

It has to be said that in the case of majority of tests now in use there has not been any systematic analysis of personality, either on an empirical level or on a conceptual one, previous to their formulation. It may be suggested that in following this procedure the makers of the tests have had the idea of the parallel instance of successful construction of Intelligence tests by Binet without a previous full theoretical analysis of the nature of intelligence itself. There is, however, an important difference between the nature of intelligence and that of personality. The former is a more definite and narrow concept than the latter. Further, it would be far from the truth to say that Binet had no theoretical idea of intelligence when he devised his tests. He had an idea, and on the right line. Within the last 30 years after his death, psychological theory has not found it necessary to revise his view that intelligence has the function of successful adaptation to environment and that it has the different intellectual processes as the instruments of its action. It is doubtful whether our plan of Personality tests has yet been able to find for itself as secure a theoretical basis as the Binet tests had at its inception.

Personality tests have been variously criticized. It has been pointed out that most of them are indefinite, arbitrary and superficial. While this criticism is largely true, it must be said that emotional and temperamental qualities constitute a more private, elusive and readily changeable aspect of human nature than intellectual ones. As an elucidation of this fact we can point to two outstanding peculiarities in Personality testing research; one is the large variety of tests being used at present, and the other is the low correlation of reliability which these tests reveal. Defective choice of traits may partly explain these facts, but I am disposed to think that the far more important explanation is to be sought in the nature of the emotional side of man which we want to measure but which unfortunately does not yield readily to tests demanding verbalized responses.

Favourable mention must, however, be made of three current Personality tests. These are designed to measure clinical traits of considerable interests, e.g. extraversion-intraversion, cyclothymic and schizothymic types, and eidetic types. The tests appear to be relatively definite and of some diagnostic value. But as Pillsbury remarks, 'the bases of classification used in the tests are relatively too narrow '[1].

On the whole, one must say with Burt [2] that the personality tests are now 'too poor for practical work'. Burt advises teachers and research students to apply them carefully. It is difficult to pass an authoritative opinion on the personality characteristics of a man from the profile sheet in which the traits are recorded. He adopts, therefore, a standardized personal interview in order to supplement the application of these tests. Real defect seems to me to lie in the fact that Personality testing is at present very much influenced by a mechanistic conception of personality. Traits are regarded as separate blocks and though personality may be defined as a total organization, it is actually indicated in summative terms. It is because we believe in this mechanical structure of personality that testers have deplored the inconsistency of a measured trait. A trait in a particular situation is really, however, the function of personality as a whole, and as such, it is apt to be variable if a change takes place within the complex structure of personality. It is a matter of common observation that a large number of persons are usually inconsistent in their behaviour. How shall we think of them? If we are to stick to the mechanical conception of personality we should regard them as unworthy of scientific interest. But science seeks the governing principle of whatever is given by nature, and the science of Psychology should not refuse to find out the principle even of inconsistent behaviour. Nothing but an insight into the dynamic structure of the personality can give us this principle.

Need for a Dynamic Concept of Personality.

The need for a revised conception of personality is strongly suggested from perusal of recent text-books of Psychology. The authors feel bound to give a summary of the voluminous research work on the subject but do not hesitate to express their dissatisfaction with the value of the main concept itself. Thus one refers to it as 'not scientific' (Wheeler); another as 'presumably popular' (Pillsbury); and a third as 'most difficult' (Murphy).

The view that personality is a complex organization with dynamic interrelation of parts has been foreshadowed in the writings of some contemporary psychologists. While reviewing the work of Psychiatry in the field of character analysis, Roback [3] seems to suggest that dynamic interpretation of character should 'take into consideration traits in operation, their origin and transformation'. He himself does not go, however, into detailed consideration of the origin and transformation of traits and gives us a theory not far different from the ordinary view, i.e. that personality consists in reflective control of instinctive impulses.

The need for a dynamic concept of personality has been emphasized by the Gestalt school of Psychology.[4] It criticizes the practice of describing personality from a list of traits. Personality is a functional whole with interacting parts some of which are dominant over others. No description can be adequate unless it shows the rôle of each part in the work of the whole. The Gestalt psychologists must be given the credit for having given us a dynamic theory of personality in its essential outline. The details of the outline have, however, to be supplied and the theory has to be given the solid support of facts gathered from the analytical study of concrete individuals. As Gestalt Psychology itself has not yet made any attempt on this line we shall have to address ourselves to other quarters. But before we do that, it is necessary to refer in brief to the question of method.

A Question of Method.

How are we to build a theory of the dynamic structure of the human personality? It can be assumed at once that such a theory must be based on empirical analysis of individuals in varying situations of life. It can also be assumed that the logical basis of inference should be what Gestalt psychologists describe as 'functional analysis'. When an organized whole with dynamically interacting parts has to be studied in its concrete entirety or in separate parts, this is the principal method to be used. Functional analysis is another name for correlated variation of functions in actual working. It corresponds to the well-known inductive method of Concomitant Variation without being fully identical with it. There seems to be at present considerable difficulty in the application of the method in the ordinary conditions of the psychological laboratory. We seldom get the whole individual functioning there and we usually have to be satisfied with a slice only of him, and that also an artificial slice. The method of functional analysis, on the other hand, has much scope of application in clinical and psychoanalytical fields as well as in the field of genetic study of children. In the first we get variation of function through pathological deviation and in the second through normal changes in the process of development. A combined approach through the study of deviation and genesis is likely to be very helpful. Conclusions based on this combined approach may finally be verified in the light of the phenomena of normal life.

Psychoanalytic Theory of Personality

I will introduce a personal note into the discussion at this point. It was during psychoanalytical experience and also during the clinical examination of problem children that I came upon the idea of the dynamic structure of the personality, and realized the very great value of the recent revision of Freudian theory of neuroses for understanding this structure. The old theory explains neuroses as the result of a conflict between some part of the sexual instinct and the conscious mind or ego. The new theory goes into a deeper analysis of the latter factor and discovers a specially differentiated part within it which is very actively concerned in the conflict but which is unconscious like the repressed sexual instinct itself. Freud has coined three special names for these three clinically distinguishable main functions of the mind, e.g. Id, Ego, Super-ego. The discovery of the Super-ego and of its origin in the social influences of early period of life appears to me to have put a new complexion to Freud's theory as a whole. The theory has become more easily understandable and we have now a surprising unity of perspective over a much wider ground and also a larger variety of phenomena than before. What may be said to be more important to an academic psychologist is that the revision brings Freudian theory closer in a sense to the general theory of mind by supplying an important link in the history of mental evolution of man from the sub-human level.

I would like to indicate this link in this paper, but before I do that, I would make one particular observation on the triad of Id, Ego, and Super-ego. In a general sense it corresponds to the other more popular triad of passion, reason and conscience which men take usually into account when judging of the character of other persons in society. One may guess from this correspondence that Freud's discovery after patient research receives considerable support from the natural intuition of the human mind. We should not, however, be blind to important differences between the two views. The meanings of terms of the Freudian triad are more inclusive, as these have both a conscious and an unconscious aspect. The new meanings are based on actual analysis of men and indicate a reason why popular estimation of it is not always correct, and why such an estimation has to be more or less a technical job. These also serve to explain why it is ordinarily difficult for a normal person to correct with his own effort even minor oddities of character. The second difference lies in the fact that, whereas the popular view would regard the three factors as distinctly separate entities, the Freudian conception recognizes their separate existence only for functional purposes but places them in a single evolutionary perspective. Genetically one is continuous with the other two. Id is undifferentiated instinct not yet organized under the unity of an Ego or self-feeling. Ego gradually develops as the Id comes into contact with reality and becomes in course of time invested with various mental powers to meet the need of progressive adaptation. Super-ego grows later out of the developing qualities of the Ego and represents a further differentiation of it. Its original function is to help the Ego in its hard task of keeping the Id in check.

The main purpose of this discourse is to emphasize that the three factors in their mutual interaction may be said to constitute the fundamental scheme of personality in an individual. If we can know the exact pattern of this interaction and its governing principle in a man, we have very little else to know from the psychological point of view so far as the dynamic core of personality is concerned. It is true that for clinical appraisement it is indispensable to take into account physiological and biological factors, e.g. anatomical and chemical peculiarities, organ inferiority, heredity, favourable and unfavourable environment, sudden and severe strain of circumstances. But, in my opinion, these are all accessory factors from the strictly psychological standpoint. We know that none of these fully explains why one should be as he is, nor also all of them taken together does it in all cases. Here we come to the question of the boundary between the science of Psychology and that of Biology. The former rises out of the latter and must have it as its base, but it is a superstructure with distinct principles of its own. In order to comprehend how the biological and physiological factors actually work we should reduce them to modes of psychological functioning.

Anyhow, I have seen in my experience that it is very much fruitful to keep the question of dynamic interaction of the three Freudian factors constantly before the mental eye and try to seek its pattern in any given individual whenever we have to deal with him from the clinical point of view. This procedure, in my opinion, helps us in psychoanalytic practice not only in the matter of giving the interpretation at the right moment but also in choosing the right type of interpretation to be given. It helps us in making a prognosis in the case of problem and even many mentally deficient children.[5] It makes it easy for us to understand better the differences not only between mental disease and normality, but also between the different types of mental diseases. It enables us to have an insight into different types of criminality as well as into the general problem of criminality. It throws light on the psychological mechanism of social relations of man and thereby points the way to true mental hygiene. I think also that the idea of dynamic interaction is capable of making important contribution for elucidating genetic significance of mental functions.

While claiming so much for the value of the new theory, it would not be scientifically right to believe that it has given us complete knowledge about the dynamic factors of human personality. Much yet remains to be done to clarify our ideas on many points. The method of approach by which Freud came to the discovery of dynamic factors of personality may be described as one of regressional analysis of functions. For a general theory of mental development on the subject we require to check and expand this analysis by results of genetic analysis of functions in the case of growing children of different types. Here is a vast field of work for Child Psychology, provided it gives up its present bias for the obsolete explanatory principle of association and takes up instead a general psychoanalytic or organismic perspective. A good beginning has already been made in this line by a number of workers both in Europe and America and we have had a very fair promise of fruitful and interesting results.

II. DYNAMIC THEORY OF PERSONALITY IN A BIOLOGICAL PERSPECTIVE.

Having pleaded for the application of the dynamic view of personality on psychological problems, general and applied, I will try to correlate it with a general theory of learning. I may justify my present effort by referring to the fact that in both the cases modification of instinct is the main subject of explanation. It is expected that such an effort may give a general biological basis to the dynamic theory of personality.

Intelligence in Animal Life.

We usually use the concept of intelligence for explaining the modification of animal instinct. In a sense intelligence is a part of instinct itself, a part that has been gradually differentiated out of it in course of evolution for the purpose of helping it in its successful adaptation to reality. We are concerned here to enquire how it discharges its instrumental function, and, I think, we can do that by entering into an analysis of the general functional principles of learning. One can form an idea about the abstract power of intelligence mainly from its concrete modes of functioning in learning.

I need not, however, go into the theories of learning. The differences between the trial and error theory and the insight theory appear to me to be unimportant. We may suppose that intelligence which is responsible for adaptive behaviour may work in two different ways, a more slow and overt way of trial and error and a more quick, economical and implicit way of insight. We may further suppose that as we go up the scale of evolution, the trial and error way is gradually replaced by the insight way. I will present here a few basic principles of adaptive behaviour in the animal world which I think both the theories may accept. Of the three principles enumerated below, the first one is usually emphasized in text-books as the all-sufficient law of learning.

But I consider that no account of the function of intelligence as the instrument of biological adaptation can be complete without the other two principles.

(1) Integration is the fundamental principle by which intelligence forms an organized reaction system for the satisfaction of the instinct. It may be split up into two phases, inhibition and facilitation. In the completed stage of learning the two phases are indistinguishable, but in the initial stages inhibition usually precedes and prepares the way for facilitation. We can think of pain as the psychological correlate of the former and pleasure as that of the latter. Quoting a word from Freud, one can say, that pain is the 'path finder' of pleasure. Though inhibition is usually helpful it is likely to be otherwise if it exceeds a certain limit. Animals in the experimental cage sometimes sit idle and worried from inhibitional effect of many fruitless efforts. Pavlov's dog is said to cease learning and even to fall asleep in advanced stages of inhibition. We know also that the inhibited child is very much averse to learning.

From the question of inhibition we may digress for a moment to the allied subject of emotion. Inhibitory effect of emotion is very well known. We do not know what is the exact physiological correlate of it, but one may guess that emotion develops at a point of sudden blockage in the path of instinctual tension discharge, ensuing in sudden increase of potential of energy in the discharge process. In support of this hypothesis one may refer to the (i) close connection of emotion with instinct, (ii) massive release of energy in emotion, (iii) the obviously reinforcing effect of many of the visceral changes of emotion. It will also explain (iv) the obvious affective character of emotions, for the qualities of pleasantness and unpleasantness may be said to vary according as the phase of facilitation or inhibition predominates in the reaction to the blockage. It will do justice also to the (v) markedly conative trend in emotional experience and would be in consonance with the (vi) thalamic 'double route' theory. (vii) The emotional significance of human conflict as revealed by psychoanalytical researches will also have a definite meaning in terms of this hypothesis.

(2) The second principle of adaptive behaviour may be described as a dynamic inter-relation between instinct and environment. It is necessary to recognize this principle in addition to that of integration. The direction of integration is determined by the given fact of this dynamic inter-relation. The importance of it is also obvious from the fact that the actual use of a completed integration on a particular occasion depends upon it. Past learning is helpful as long as the dynamic relation between the instinct and the environment is not disturbed. Kurt Lewin[6] has referred to the importance of recognizing of this dynamic relationship between instinct and environment for the

explanation of behaviour. It seems to me that the obviousness of this relationship must make us concede a perceptual sense of reality to the animal mind. It implies also that the primary consciousness on the plane of instinctual excitation is projective.

(3) Capacity for sustained tension is the third principle of adaptive behaviour. In a broad sense, the activity of an instinct consists in a process of tension discharge which continues in the form of a series of organic movements till a sensory contact with a particular object helps in removing the tension altogether. If the discharge takes place at a high potential or becomes excessive, either by the very nature of the instinct, or for reasons of blocking, as in the case of emotions, the function of intelligence in leading the instinct to its goal becomes very much affected. From biological point of view a necessity, therefore, arises for keeping the tension under check. To what extent this is actually done depends perhaps partly upon the inherited strength of the instinct and partly on its acquired strength from past use; but there is no doubt that if intelligence is to act as an efficient principle of regulation, it should gradually take upon itself some responsibility for keeping the tension under control during the process of learning.

The effect of the capacity for sustained tension is very important for further mental development. As it initiates control over the motor end of reaction, it may be said to be the fundamental initial condition for appearance of higher forms of intellectual activity above the level of perception, by making available for them energy that would have otherwise gone into the motor system. As one goes up from grade to grade in the animal world, one can mark that the adaptive behaviour gets more and more complex, and along with it, the capacity of control over the motility increases. It is difficult to say very definitely whether mental powers on the intellectual side also increases at the same rate as these do, but from the increasing facility of learning there seems to be no doubt that ability of sense discrimination and of organic memory systematically improve with rise of grade. When we come to the insight stage, control must be said to have been very marked. For, it indicates substitution of direct motor impulsion by sensory or imaginal activity.

We may summarize our discussion of this part in one sentence. For the sake of successful adaptation to increasingly complex environment, instinct differentiates out of itself what is known as intelligence which helps it with its three fundamental characteristics or principles: Integration, Effecting of dynamic relation of instinct with environment, and Capacity for sustained instinctual tension.

Development of Human Personality.

Having given an account of the principles governing modification of animal instincts, I will now enquire into those of modification of human instincts and try to see how these enter into the making of the human personality. For our knowledge on this important subject we are indebted to psychoanalysts. There is good reason for believing that the basic structure of personality is laid within the first five years. But about the steps and exact principles our knowledge is still very much hypothetical. As Anna Freud says, 'the chronology of the psychic processes (leading to the growth of the personality structure) is still one of the most obscure fields of analytic theory.'[7] I will confine myself in the summary presented here to broad points which many psychoanalysts may be disposed to accept. It is needless to say that the account would not be free from interpretations based on personal observation and reflection.

We may present the account of early personality development in three broad stages.

1. *Inadequacy of organic intelligence and compensation by the social environment.*

Intelligence has to mediate between instinct and environment. Both these factors are so complex and varied in the case of human baby, that his intelligence would have certainly failed to cope with them, if there were no supplementary principle of adaptation provided by the society. This adaptation given through the loving care of the mother or nurse not only allows his immature intelligence to develop without undue strain, but also actively and systematically assists it in its work of acquisition of skill and knowledge and also in its wider work of social adaptation.

It is important to consider the psychological rôle of the mother. Beginning perhaps as one out of many objects in the environment, she soon acquires special significance as a source of fresh stimuli, as an object of reactions, and also as a parallel mind with same feelings and attitudes as those of the baby himself. In psychoanalytic terms, she draws considerable amount of libido cathexes upon herself. As Vernon Jones puts it, ' the mother forms a part of the child '. Perhaps it would be more apt to say that between them the mother and child form a sort of 'compound mind' across space, one half of it lying in the ill-defined body of the child and the other half projected out into the mother.

There is no doubt that an emotional rapport is soon established between the two, and, on the basis of this relation, there takes place much mutual direct understanding. It gives the helpless child a much needed feeling of security and helps him in addition to acquire attitudes and ideas about many things in life. In this sense, it is a great socializing process. Majority of psychoanalysts give it the name of primary identification. It seems that we have not yet grasped the psychological nature of this process very clearly. Some take it as identical with introjection. I am inclined to think that identification is the primary form from which introjection and projection have been differentiated as two separate phases. These latter processes are to be found only when a distinct Ego sense has already developed. In support of my view I may also point to the fact that in extreme instances of schizophrenic regression to the earliest level the distinction between the self and the reality vanishes, and both behaviour and gestures indicate re-enacting of primary identifications. In hypnotism, also, the sense of distinct self is gradually abolished through progressive rapport, and when a state of extreme suggestibility is produced, it is this process of identification that seems to be operative in my opinion.

Anyhow, there is no doubt that identification forms a very important mode of quick learning as well as of basic character education, specially in the earliest stage. It is not confined to the child's relation with the mother but extends to his relation with other persons and even non-personal objects, provided he can have an emotional point of contact with them. The various identifications seldom make a harmonious system but usually contradict each other. Contradictory identifications sometimes appear as split apart in the verbiage of little children in play and in that of schizophrenic patients. Early identifications usually run counter also to the lessons of one's own experience. All these contradictions put a heavy strain on the synthetic function of intelligence, and as a consequence, our life grows up with many self-contradictory beliefs and attitudes. Many of us have met with brilliant students of science who would not allow their scientific curiosity even to peck at dearly cherished superstitious beliefs. We know that these beliefs have been fed upon emotional identifications of early childhood and are, therefore, so invulnerable.

Let us digress here for a moment on the educational function of the family. That a family with healthy outlook is a great educative force is borne out not only by psychoanalytic experience, but also by statistical research. Speech defect in feeble-minded children of approximately same I.Q. has been found by me to be greater in the case of 'poor' homes than in the case of moderately good homes. Gindl and Hetzer report an interesting study which shows that institutional children are about one-half retarded in general development, and about two-third retarded in language, as compared even with foster children. If the influence of the family on early intellectual growth is[8] so great, its influence on emotional and moral growth is far greater. I have seen in connection with examination of Children's Court and Reformatory boys as also during visits to juvenile prisoners in jail, that most of juvenile criminals have had bad homes.

2. *Clash with social environment.*

As the child grows up, his demands and pleasure cravings increase, and he usually begins to play a little tyrant. It becomes necessary then not only to disappoint him but also to check him in the interest of his education and future relation to society. The same mother who has indulged, has often to refuse and to scold. If she is too soft to do this, she gets someone else, usually father, to do it for her. The child seems to feel that a wrong is being done against him. He reacts to the disappointing mother by aggression. But, as she loves him and still continues to give him pleasure in so many other ways, he has love for her, too. A state of ambivalency of love and hate arises with respect to the mother, and later on father also, and may come out for a time in open expression in the behaviour of the child.

Partly for internal and partly for external causes, the first acute period of aggression and obstinacy is from the end of the second year to the end of the third. He seems to resent for being thrown out of that emotional closeness which we have described as a sort of 'compound mind' between him and the mother, and his increased aggression may be interpreted as a natural expression of this resentment. One may think that with growth of intelligence and of the unifying sense of self and with a fair amount of mastery over the basic habits of life, the child is in a way prepared by now for depending more upon his own independent intelligence and for detaching himself from too much reliance on mother. The emotional clash with the environment may be said, therefore, not to be useless and in vain.

It does not take long time for the child's intelligence to realize effects, immediate and remote, of aggressive attacks on others. The act of aggression gives him some pleasure no doubt, but it means loss of greater pleasures. It is not the scolding and beating that really matter so much but the sign of withdrawal of love by those upon whom he has been so long emotionally dependent. The very suggestion of this withdrawal fills him with a chilling sense of insecurity. He deflects his anger on other persons and even things. But that is not enough. In order to preserve his positive relation of love to society he tries at last to check his aggression at its very source, e.g. in his mind. I have seen children under 2 years showing signs of distressful anxiety in anticipation of their reactions of anger in connection with particular situations of conflict.

We are already on the threshold of the next stage of our account; for, the child may be said to have begun internalizing his aggression in order to spare the same to the world. But Freud believes that the full impetus for this essential characteristic of the next stage is exerted only after the Oedipus complex distinctly appears on the scene.[9] This complex directs strong sexual cravings to mother and aggressive hostility towards father. Perhaps partly because of a phylogenetic fear in connection with taboo of incest, and partly because of the fear arising from the direct perception of the angry father's great power, a change of attitude becomes very much necessary on the part of the child and he tries to overcome his Oedipus complex. Anyhow, one may say that the complex places him in a very critical relation with the world. He comes at last to perceive that the real source of danger lies in his own impulses and tries to escape from the critical situation in various ways. Following suggestions of her father in his recent writings, Anna Freud enumerates as many as ten mechanisms of escape from it.[10] But the most effective one is at last found to be repression. Connected with the operation of this mechanism is the question of the rise of the Super-ego.

3. *Origin of the Super-ego.*

The Super-ego is a permanent principle of control erected within our mind, so that with its help the Ego may dispose of its own impulses, specially those of sexual and aggressive nature, in such a way as not to wound society and not to seriously affect its relation to the world. We may say that with its rise the first outline of individuality becomes complete in the human sense.

The exact meaning of the Super-ego is not very clear in psychoanalytical literature, nor is there agreement of view about the time and manner of its origin. It seems to me we should consider it in two parts, one conscious and the other unconscious. The conscious part holds forth before the mind an image of what one likes to be and can be traced to parental injunctions and suggestions. It can be appropriately described as the Egoideal and is certainly a great internal socializing force. The unconscious part, which we may call the real Super-ego, helps the mind in another way, e.g. by keeping watch over the objectionable impulses from which the latter wants to escape for the sake of reality adaptation. It must be said that it does its duty very zealously. The condemned tendencies, connected as they are with basic instincts, try always to secure gratification by getting access in some form or other into the somatic or mental processes. In doing this they may, and often do, escape the notice of the conscious mind, but seldom that of the Super-ego, which thus seems to have an uncanny ability of 'unconscious perception'. But the Super-ego does more than watching. It is always ready to punish, and it does punish, whenever the impulses make efforts to come out. It is only in one case that it does not punish, e.g. sublimation. Like the Egoideal, it is also an internal socializing force, but of a punitive character.

The Super-ego arises by introjection of the prohibitions, threats and moral advices of the parents. Several instinctual motives have been cited to supply an energy basis for it, e.g. getting parental love and power, narcissistic displacement, inverted Oedipus complex, and recoil of aggression upon self.[11] Melanie Klein[12] regards the last factor most important. Its importance is indicated from the fact that 'there is by no means always an exact correspondence between the severity of the Super-ego and the actual sternness of the parents' (Flugel).

One of the consequences of the development of the Super-ego is that the whole mind gets a new structure. A distinction is introduced within instinctive impulses; some having access to the conscious mind as before and being helped by its power of intelligence, and some again being denied this help and access. The latter is repressed and is to be called Id. (In psychoanalytic literature, however, Id is often indiscriminately used for all instinctive impulses.) The Super-ego is the repressing counterpart. The differentiation of the Super-ego serves to make the mind more alert than before. I think we should use the word 'Ego' only when the Super-ego appears and there arises a keen sense of 'self' in distinction to others. We may imagine that while the Ego has its face normally turned to the perceptual world, the Super-ego has its eyes on the Id, which of course wants to look with its face averted from either. But if any of the latter two structures has to act, it must do so through the bodily or the mental part of the Ego.

Place of Intelligence in Human Personality.

Let us look at the total effect of the new structural change for a moment. Reality, acting mainly through the mother, draws love of the young child upon itself and uses this love as an important lever for educating and socializing him. With love comes out very soon his aggression as well. The socializing process is placed on a firm footing, only when, as a result of conflict between him and the world, he internalizes a considerable part of his aggression and also of his sexual impulses. He seems to introject the outer principles of control for this purpose, but he cannot make them work, unless he turns the energy of the aggression upon himself in the form of self-criticism and, also in the more severe form of self-punishment in case of autoplastic release of Id impulses. In normal persons there is less of self-punishment, in psychoneurotics it is greater and more severe, in psychotics attempt is made to throw it out, with less success in paranoia, but more in dementia præcox. Taking everything together, one may say that in withdrawing his aggression from the world upon himself so as to spare it to the latter, man has been acting Jesus-like ever since the rise of civilization.

In making this review we are particularly concerned to know how is the position of intelligence in the total scheme of life affected by the change. Is it still continuing as the main regulating principle? In one sense, it is not; in another sense it is. In a narrow sense it is now relegated to a subordinate rôle of helping only the intellectual activity of the Ego in its relation with external reality. In a wider sense, its activity may be regarded to be still extended over the whole field of Ego activity. We may follow this latter suggestion better if we enquire how the essential principles of the biological function of intelligence are distributed under the new dispensation. (*a*) The first one of integration is to be found not only in the restricted application of it in the form of conscious learning and reasoning, but also over the life activity of the Ego as a whole in its constant attempts to harmonize forces of love and aggression as well as to bring together self and the world into a unitary functioning of sublimation. The same harmonizing tendency is illustrated in pathological cases from the Ego's efforts at balancing, either in the form of a symptom or that of a compensation, of the opposed forces of Id and Super-ego. Repression may be regarded as a special and complex form of biological inhibition, both serving the integrative function of the mind in the same general way. Moreover, there is endeavour on the part of the Ego to bring up into the light of conscious intelligence the disharmonious tendencies of the mind in the form of philosophy as well as in the form of rationalization. (*b*) The second principle of dynamic functional relation with reality is represented in the chief direct function of the Ego, e.g. perception of reality. Even in cases of psychoses, where the Ego appears to be a closed system, cut off from reality, the impressions of the latter are not absent altogether, but manifest themselves in an introjected or subjective plane. (*c*) The third principle of capacity for sustained tension which we have suggested as an essential biological condition for the development of intellectual powers underlies the will of the developed Ego acting with the help of such powers. The Super-ego which is described as a growth out of the Ego may be regarded as a special factor in this process of control. In a word, though the Super-ego plays the most important part in the change, and is also more directly active in neuroses, the principal hero of the drama of the mental life is still undoubtedly the Ego with intelligence as its greatest ally.

If we can indulge in a little speculation, we may say that the same intelligence that has successfully helped our animal ancestors in their work of adaptation is still trying to help us. It has, however, to serve a more complex need of adaptation in our case, e.g. adaptation of instinct to physical reality as well as to civilized society. We must say that it is groping for way and has not yet been able to develop new technique. Psychoanalytic research may be expected to help this process of further evolution of intelligence by giving us knowledge about the subtle ways in which its purpose is being baffled at present. We may hope that it will prepare the way for a new education by which our intelligence will acquire new powers and become thereby a more efficient and balanced principle of regulation of life. The aim of education and that of mental hygiene is the same in the long run.

III. PATTERNS OF DYNAMIC STRUCTURE OF PERSONALITY.

The three structures of Id, Ego and Super-ego form a continuously active system, one part of which is in dynamic interaction with the other two. A change at one end leads to correlated changes at other ends. Except in advanced types of psychoses there is outflow of energy from the three structures of the personality into external reality, so that functional connection between the latter and the self remains possible. Ego has of course direct connection with reality, but the contents of the other two cannot go out to it except by a special mechanism which is called Projection. By it, external objects, persons, and social institutions become invested with unconscious tendencies of the Id or Super-ego. Normal life has been possible because of this projection, for it provides a safety valve for what the Ego would not directly allow to be expressed. A considerable amount of projection underlies our normal interests as also the creative activity of Arts. It becomes pathological, as in psychotic delusions because of the special nature and direction of the contents projected. These delusions are usually of two types, grandiose and persecutory, and reflect expression of projected Id and Super-ego impulses in a self-directed form. Opposed to projection is introjection by which qualities and tendencies of external objects are believed to be one's own and which forms a second mechanism of connection of the personality with Reality.

Once the pattern of personality structure is set in childhood, it constitutes a sort of Herbart's 'apperception mass', assimilating fresh experiences and always trying to maintain its general outline. Changes take place sometimes under the influence of important (from the individual's own point of view) environmental forces specially of the social type or due to sudden change of instinctual energy as in puberty or climacteric. Appearance of mental disease in advanced life is an obvious instance of change of dynamic pattern for the worse. Relatively speaking, more change is possible in the Ego than in the Id and the Super-ego. From the theoretical point of view we may define the healthy mind to be one in which all the three structures harmonize and retain their plasticity of adaptation to reality till late in life. In the neurotically minded, on the other hand, plasticity is considerably affected by the fixation of the last two at an earlier stage.

Attempts have been made by some psychoanalysts in recent years to define patterns in different mental diseases. Notable among them are Alexander[13] and Schilder.[14] The former has dealt mainly with psychoneurotic patterns and the latter with psychotic ones. I will briefly try to illustrate in a general way the specific type of dynamic interaction in two common neuroses.

In conversion hysteria the Ego develops pain at the same somatic point as is used as a substitute for a repressed sexual excitation. The pain is the punishment that the Super-ego inflicts on it for allowing itself even a disguised Id gratification. We may say that in the hysteric symptom all the three factors meet into a sort of dynamic unity at a single point. One of my patients had extreme neurotic smarting of the eyes whenever he used them for voyerish purpose.

In obsession neuroses the mechanism by which Id and Super-ego interact is different. They apply themselves on the Ego through separate processes. Three alternative mechanisms are indicated here. (1) The really reprehensible element may appear as a meaningless thought whereas the Super-ego punishment may be given as a painful compulsive act. (2) Or both Id and Super-ego may appear as isolated mental processes, one expressing displaced aggression and the other some anxiety-provoking haunting sense of humiliation or of sin. (3) Sometimes the punishment of the Super-ego is dynamically enacted through some accident or camouflaged provocation of a superior authority before the repressed impulse is gratified. Many obsessive symptoms are really expiatory bribes to the Super-ego, so that after a technical punishment the objectionable impulses may be permitted. A young man could not go to the girl he secretly loved without making some sort of unconscious sacrifice or loss. Even when he found himself alone in her company, he would forget what he had thought of saying and would instead go through silly acts in a most cursory manner.

In many apparently normal characters also, the mechanism of neurotic interaction of Id and Super-ego is very marked. I know a brilliant young man who would interview many office-masters and produce a very good impression; but, just on the point of final success for which he had worked up so patiently, he would usually let something out of him that would suddenly change the mind of his well-meaning would-be patron. I know of another who has often spoiled his chance of success in life by delay and postponement at the right moment on very petty excuses.

With the help of the theory of dynamic structure of personality it becomes easy for us to understand the various types of criminals. In the first place, there is the psychotic type in whom Id and Ego seem to make an alliance together to overthrow the Super-ego and carry out their attack against its originator, the society. In the second place, there are criminals who commit crime out of a sense of guilt, and seem positively to 'seek' punishment, and who may be described as obsessive type of criminals. In the third place, we have another type of criminals in whom the Super-ego development is comparatively weak, either on account of poor early social influence, or arrest of intellectual powers, or both. They form the deficiency type. If the description given here is correct, then the proper way to deal with the first type of criminals is some suitable form of sublimation of their abundant aggressive energy, and failing that, isolation from society. What is really needed for the second type is psychological treatment. The third type requires re-education according to natural capacity, and in extreme cases, protection and care. Many of the last type are prone to fall easy victims to intelligent criminals of the first type.

We have no time for attempting a logical classification of possible patterns of personality on the basis of our analysis, but there is no doubt that such a classification would be interesting not only from the clinical point of view but also from that of vocational psychology. In choosing a man with a particular interest and aptitude for a vocation it is very important to know if these enjoy the stability of a sublimation or suffer from unbalanced character of Id cathexis, or has the inhibited character of a severe Super-ego influence.

PERSONALITY STRUCTURE AND SOCIETY.

We are inclined to emphasize heredity as the more important factor in the determination of human behaviour, and specially of individual personality. In the light of recent researches about the principles of personality development one cannot, of course, deny the influence of heredity, but must feel disposed to call in question the usual amount of emphasis given to it. It appears to me that in many cases the old belief in Fate masquerades as the principle of heredity. Our discussion has at least brought out the great importance of the social factor on the shaping of a healthy pattern of personality in the individual. We may go further and say that the social factor plays an important part not only in the formation of a personality but also in helping it to keep within healthy lines of development throughout life. It is true to say that individual mental health and progressive outlook of society go hand in hand. I may quote here a case for illustration of my point. I had to deal some time ago with a problem child of 11 years. On his transfer to a poor type of muffasil school he became quarrelsome and sulky, but, on the whole, more nervous than before. In his former school he had been very good both in behaviour and studies, though not without some sign of general nervous tension now and then. It became evident that the real reason for the problem behaviour was the withdrawal of the opportunity of competition with other bright boys on his transfer to a school where he had no equal in intelligence. The competition had given him sublimation of his aggression the interference of which led by regression to a pathological form of alternation between open aggression and fear. On my advice the boy was sent to another school to fight out his aggression, and he very soon made rapid improvement before much havoc could be done through social repercussions of his bad behaviour. The example indicates how society is responsible not only for the formation of a healthy pattern of personality structure but also for helping it on ever afterwards.

By way of conclusion, I may refer to the question of social morality and hint at its bearing on the dynamics of personality. Psychology has been charged with undermining our morality and thereby leading to social chaos. We may reply to this charge by saying that as a science of human nature it only finds what is there in it already. No scientific analysis can make human nature more moral or immoral than it is in itself. Is our science to be blamed for laying the finger at the real point of weakness in our out-of-date morality? If it has done that, it is not for removing morality from life, for no human life is possible without it; but in the interest of morality itself. Like the morality of the neurotic personality, our traditional morality is fixated to a primitive form and, being a static institution of control, knows only to prohibit, to warn and to punish. As a result of this fixation, our erotic and social life cannot go out into fresh adaptive achievements and we find in the world to-day a huge mass of human energy turned mad and destructive. A demon of aggression is stalking over the world and we have wars, death-dealing inventions of science, communal fights and jealousies of all descriptions. Modern Psychology points to a way out of the emotional tangle of man's love and aggressive impulses. Sublimation! Shall we be able to bind our hate and aggression by outwardly directed love?

It is for future humanity to answer that question, but we can say that it is not man's instincts which are alone to blame but also his blind morality and narrow education which would not recognize needs of progressive adaptation and which would not allow his instincts to grow along fresh paths of sublimation.

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Proceedings of the Twenty-sixth Indian Science Congress

PART III—ABSTRACTS

CONTENTS

PAGE

1. Section of Mathematics and Physics 1
2. „ „ Chemistry 37
3. „ „ Geology 103
4. „ „ Geography and Geodesy 109
5. „ „ Botany 115
6. „ „ Zoology 129
7. „ „ Anthropology 149
8. „ „ Medical and Veterinary Research .. 157
9. „ „ Agriculture 181
10. „ „ Physiology 203
11. „ „ Psychology 219

SECTION OF MATHEMATICS AND PHYSICS

President :—K. R. Ramanathan, M.A., D.Sc., F.N.I.

Pure Mathematics

1. The application of group-characters for the determination of normal modes.

R. Vaidyanathaswamy, Madras.

2. Further contributions to the theory of non-linear integral equations.

M. Raziuddin Siddiqi, Hyderabad (Deccan).

In continuation of the work reported in the *Proc. International Congress of Mathematicians*, Oslo, 1936, *vol.* 2 and *Proc. Ind. Acad. Sc.*, 6 (1937), a more general type of infinite system of non-linear integral equations is considered in this paper, viz., the system:

$$u_n(x) = f_n(x) + \int_0^x g_n(x, y) \sum_{r,\,s} \sum_{\substack{k_1,\,\ldots,\,k_r\\ l_1,\,\ldots,\,l_s}} h_n(y, k_1, \ldots, k_r, l_1, \ldots, l_s)$$

$$\times\, u_{k_1}(y) \ldots u_{k_r}(y) u_{l_1}(y) \ldots u_{l_s}(y)\, dy \,.\, (n = 1, \ldots, \infty) \qquad \ldots \qquad (1)$$

The numbers n, $k_1, \ldots. k_r$, $l_1, \ldots.,$ l_s, r, s, take all positive integral values, and f_n, g_n, h_n, are sequences of functions defined for the domain:

$$0 \leqslant x < \infty, \quad 0 \leqslant y \leqslant x < \infty \qquad \ldots \qquad \ldots \qquad \ldots \qquad (2)$$

They satisfy the relations:

$$\sum_n \left| h_n(y, k_1, \ldots, k_r, l_1, \ldots, l_s) \right| < ab^{r+s} P_1(r) P_2(s),$$

$$\sum_n \left| f_n(x) \right| \leqslant c, \quad \left| \int_0^x g_n(x, y)\, dy \right| \leqslant d$$

for all $n \geqslant 1$, all x, y in (2), all k's and l's$\geqslant 1$. a, b, c, d are absolute constants, and $P_1(r)$, $P_2(s)$ denote polynomials. The solution of the system (1) is determined by means of successive approximations

$$u_n^{(m)}(x)(m = 0,\ 1,\ \ldots \infty).$$

The series

$$\sum_n \left| u_n^{(m)}(x) \right| \quad \text{and} \quad \sum_m \sum_n \left| u_n^{(m+1)}(x) - u_n^{(m)}(x) \right|$$

are proved to be uniformly convergent, showing that the approximations are also convergent.

Then the existence and uniqueness of the solution is established.

3. On certain self-reciprocal functions.

S. C. Dhar, Nagpur.

Following Hardy and Titchmarsh, a function is called self-reciproca in the Hankel-transform if

$$\phi(x) = \int_0^\infty \sqrt{xy}\, J_\nu(xt)\phi(t)\, dt \quad .. \quad .. \quad .. \quad (1)$$

where $\nu > \pm\frac{1}{2}$ and then $\phi(x)$ will be called R_ν. If however $\nu = \pm\frac{1}{2}$, (1) reduces to the Fourier sine or cosine transform. The object of this paper is to investigate Whittaker functions which are self-reciprocal in the Hankel-transform. By the help of the infinite integral of the W function, it is shown that the function

$$e^{\nu-2k+\frac{1}{2}}\, e^{-\frac{1}{4}x^2}\, W_{k,\, k-\frac{1}{2}}(\tfrac{1}{2}x^2) \quad \text{is} \quad R_\nu$$

and so also is the function

$$e^{\nu-2k+\frac{1}{2}}\, e^{-\frac{1}{4}x^2}\, W_{k,\, -k+\frac{1}{2}}(\tfrac{1}{2}x^2).$$

4. Some infinite series involving the product of Bessel functions and Weber's parabolic cylinder functions.

R. S. Varma, Lucknow.

In this paper two infinite series involving the product of Bessel functions and Weber's parabolic cylinder functions are summed up in terms of Humbert's functions by the help of Operational Calculus.

5. A pair of functions which are Hankel transforms of each other.

R. S. Varma, Lucknow.

The object of this paper is to give a pair of functions, which are J-transforms of each other. This is done by summing up an infinite series of Sonine's polynomials and then using a known example of a function which is self-reciprocal in the Hankel transform.

6. On the axial lines of a quadric.

C. V. H. Rao, Lahore.

The paper consists of a number of constructions throwing fresh light on known results, with inferences and generalizations.

7. On integral functions of finite order.

S. M. SHAH, Aligarh.

Let $f(z)$ be an integral function of finite order ρ; $N(r)$ = the number of zeros of $f(z)$ in

$$|z| = r \text{ and } M(r) = \operatorname*{Max}_{|z|=r} |f(z)| .$$

In this paper I prove a number of results about

$$g(r) = \frac{\log M(r)}{N(r)}$$

(*a*) without assuming any condition on the growth of $N(r)$ or $\log M(r)$, (*b*) assuming some such condition. In particular, I prove that if

$$N(r) \sim Ar^{\rho} (l_1 r)^{\alpha_1} \ldots\ldots\ldots\ldots (l_k r)^{\alpha_k}$$

$$(l_1 r = \log r\,;\ l_k r = \log (l_{k-1} r)) \text{ then}$$

(1) If ρ and $A > 0$, α's real

$$\text{then } \lim_{r\to\infty} g(r) \geqslant \frac{1}{\rho}\,;$$

(2) If $A > 0$, α's$\geqslant 0$, ρ non-integer

$$\text{then } \lim_{r\to\infty} g(r) < \infty\,;$$

(3) ρ and $A > 0$, α's$\geqslant 0$

$$\text{then } \lim_{r\to\infty} \left\{ g(r) \,\middle|\, \log r \right\} \leqslant 1$$

and some more results. I further show that the results are the 'best possible' ones. I also construct two integral functions to show that

(4) If $\phi(r)$ be any function such that

$$\lim_{r\to\infty} \frac{\log \phi(r)}{\log r} \leqslant \rho$$

then there is an integral function of order $\rho \geqslant 0$ for which

$$\lim_{r\to\infty} \phi(r) g(r) = 0\,;$$

(5) There is an integral function of order $\rho \geqslant 0$ for which

$$\lim_{\to\infty} \frac{g(r)}{\phi(r)} = \infty .$$

8. On certain expansions involving Bessel functions.

S. C. MITRA, Dacca.

The author adopts Barnes' (*Proc. L.M.S.*, 2, 59–116, 1906) contour integration method and obtains several expansions involving hypergeometric functions. Then, by giving special values to the parameters, the author deduces several interesting expansions involving Bessel functions.

9. On sphero-tangential equation of a surface.

D. N. Sen *and* V. Rangachariar, Patna.

The tangential equation of a surface is obtained by finding the condition among $\frac{l}{p}$, $\frac{m}{p}$, $\frac{n}{p}$ such that the plane $lx+my+nz+p=0$ may touch the surface. Instead of the plane we may take a sphere

$$x^2+y^2+z^2-2\alpha x-2\beta y-2\gamma z=0$$

and find the condition among α, β, γ such that the sphere may touch the surface. The corresponding equation may be called the sphero-tangential equation of the surface. The object of the paper is to study the corresponding results as applied to certain surfaces. The sphero-tangential equation will correspond to the envelope of planes bisecting perpendicularly the joins of O to the points on the surface. It is shown that for a system of ω-axial spheres, the sphero-tangential equations will correspond to a system of conicoids of revolution enveloped by two fixed cones and through any point in space two members of the system pass. It is also shown that if the sphero-tangential equation be of the second degree, then the surface is one having a conic-node at O and a line of singularity along the circle at infinity. The degree of the sphero-tangential equation of a surface of degree n is shown, in general, to be $n(n^2+2n-1)$.

10. Generalizations on partial fractions in determinantal forms.

D. N. Sen, Patna *and* R. Mahanty, Cuttack.

Professor Turnbull showed (*Proc. Edin. Math. Soc., Vol.* 1, *Ser.* 2) how partial fractions in determinantal forms can be obtained for $f(x)/Q(x)$, where $Q(x)$ consists of simple unrepeated or repeated factors $(x-a)$. The object of this paper is to examine similar results when $Q(x)=0$ has imaginary roots. Elegant forms are obtained when $Q(x)$ has factors of the type $x^2+a_r^2$ and also of the type $x^2+a_rx+b_r$.

11. On an interpolation formula for triple integration.

P. N. Das Gupta, Patna.

Burnside has given [*Mess. of Math.* (2), 37 1908], an interpolation formula for double integration, where the integrand is a polynominal in two variables, of degree 5 at most. In the present paper, an extension of his formula has been obtained for three variables for polynomials of the same degree.

12. On a pair of factorable recurrents.

S. C. Chakrabarti, Jadavpur.

1. Denote

$\begin{bmatrix} r \\ c \end{bmatrix}_2=(a^r-1)\,(a^{r-2}-1)\,(a^{r-4}-1)\,\ldots\ldots(a^c-1)$, where r and c are both even or odd integers, $r>c$;

${}^rS_x$ = the sum of the products of r factors $1, a, a^2, \ldots a^{r-1}$ taken x at a time and

$$C_5 = \left|\begin{array}{ccccc} {}^6S_1 & {}^6S_2 & {}^6S_3 & {}^6S_4 & {}^6S_6-1 \\ 1 & {}^5S_1 & {}^5S_2 & {}^5S_3 & {}^5S_5-1 \\ & 1 & {}^4S_1 & {}^4S_2 & {}^4S_4-1 \\ & & 1 & {}^3S_1 & {}^3S_3-1 \\ & & & 1 & {}^2S_2-1 \end{array}\right|_5.$$

Then the general recurrent of the same type as C_5, viz.,

$$C_n = 0 \quad \text{or} \quad (-)^{\frac{n-1}{2}} \begin{bmatrix} n \\ 1 \end{bmatrix}_2, \text{ according as } n \text{ is even or odd.}$$

2. Denote

$$D_5 = \left|\begin{array}{ccccc} {}^6S_1 & {}^6S_2 & {}^6S_3 & {}^6S_4 & a\,{}^5S_1+(-)^5 \\ 1 & {}^5S_1 & {}^5S_2 & {}^5S_3 & a\,{}^4S_1 \\ & 1 & {}^4S_1 & {}^4S_2 & a\,{}^3S_1 \\ & & 1 & {}^3S_1 & a\,{}^2S_1 \\ & & & 1 & a \end{array}\right|_5.$$

Then

$$D_n = (-)^{\frac{n-2}{2}} \begin{bmatrix} n+1 \\ 3 \end{bmatrix}_2 \quad \text{or} \quad (-)^{\frac{n-1}{2}} \begin{bmatrix} n \\ 1 \end{bmatrix}_2, \text{ according as } n \text{ is even}$$

or odd.

13. On an Algebraic identity and a unit recurrent.

S. C. CHAKRAVARTI, Jadavpur.

1.

$$\sum_{x=0}^{r-k} (-)^x \frac{\begin{bmatrix} x \\ 1 \end{bmatrix} a^{kx}}{\begin{bmatrix} k+x \\ 1 \end{bmatrix}} {}^{r-k}S_x = \frac{1}{(a^r-1)\begin{bmatrix} k-1 \\ 1 \end{bmatrix}}, \quad r \geqq k,$$

where $\begin{bmatrix} r \\ c \end{bmatrix} = (a^r-1)(a^{r-1}-1)(a^{r-2}-1)\,\ldots\,(a^c-1)$, $r-c$ is a positive integer, $\begin{bmatrix} r \\ c \end{bmatrix} = 1$, if $r=0$ and c, a positive integer and ${}^rS_x$ denotes the sum of the products of r factors $1, a, a^2, \; . \; . \; . \; a^{r-1}$ taken x at a time.

2. Denote

$$r_4 = \left|\begin{array}{cccc} {}^rS_1 & {}^rS_2 & {}^rS_3 & {}^{r-1}S_3a^3 \\ 1 & {}^{r-1}S_1 & {}^{r-1}S_2 & {}^{r-2}S_2a^2 \\ & 1 & {}^{r-2}S_1 & {}^{r-3}S_1a \\ & & 1 & 1 \end{array}\right|_4.$$

Then the general recurrent of the same type as r_4, viz.,

$$r_n = 1, \; r \geqq n.$$

Applied Mathematics and Statics.

14. Some boundary value problems of the theory of elasticity.

Bibhutibhusan Sen, Krishnagar.

In this paper some two-dimensional boundary value problems of the theory of elasticity are solved by using complex variables. Airy's stress function is usually employed for solving two-dimensional problems of elasticity. It is shown in this paper that the solutions can be directly obtained from the stress equations of equilibrium and compatibility without introducing this function.

15. Some problems of finite strain.

B. R. Seth, Delhi.

In two recent papers (*Phil. Trans. Roy Soc. A*, 234, 231–264, 1935; *Proc. Roy. Soc. A*, 156, 171–192, 1936) the theory of finite strain in elastic problems has been developed on the hypothesis that the second order terms in the components of strain may not be neglected. Like the body-stress equations these components have been referred to the actual position of a point P of the material in the strained condition, and not to the position of a point considered before strain, as has been invariably done by previous investigators. No account has been taken of the generalized Hooke's Law. The only assumption which has been made with regard to the stress-strain relations is that in isotropic elastic bodies they are in the simplest tensor form that we can take, viz.,

$$\widehat{xx} = \lambda(S_x+S_y+S_z)+2\mu S_x,$$

$$\widehat{yz} = \mu\sigma_{yz} \text{ etc.},$$

in the usual notation. As may be expected, the corresponding tension-stretch curve of the ordinary theory is now not a strainght line, but it is not unlike that which is actually found in some materials (*Loc. cit., Phil. Trans. Roy. Soc.*, p. 237).

This method has already been applied to many problems including those where the ordinary theory cannot give any satisfactory result. To give an example of the latter we may mention the case of a thick cylindrical tube turned inside out under no surface tractions. The object of the present paper is to extend the theory to the following cases:

(*a*) A hollow cylinder under radial body force with special reference to a rotating-shaft.

(*b*) A spherical shell under radial body force with special reference to a gravitating shell.

16. Uniform motion of a sphere or a cylinder through a viscous liquid.

B. R. Seth, Delhi.

The uniform motion of a sphere or a cylinder through a viscous liquid is discussed by introducing an external force X in the direction in which the body is moving and without neglecting the inertia terms.

The assumption of a steady and symmetric flow has given the following results :—

(1) Oseen's criticism of Stokes' solution that it is defective at points distant from the sphere holds good only when the liquid flows past the fixed sphere, and not when the sphere is moving uniformly through it.

(2) If the kinetic energy can be infinite, it should be possible to use Stokes' solution when U^2/a is too small to be taken into account.

(3) When a big sphere moves slowly through a slightly viscous liquid the value of the drag should be at least greater than 1½ times that given by Stokes. In the case of a circular cylinder it should be greater than $4\,\pi\mu U$. In these cases the Reynold's number, R, has a finite value.

(4) As R increases from 0 to ∞ the kinetic energy of the fluid decreases from infinity to the value for the corresponding irrotational motion.

(5) For a very big sphere or a cylinder moving slowly through a slightly viscous liquid the motion is everywhere irrotational except in a thin layer near the boundary. R is now very large.

17. A note on grid sampling.

P. C. MAHALANOBIS, Calcutta.

In field surveys, the sampling units or grids usually have definite spatial connexions. In a purely random field such connexions are absent, and the sampling variance (ignoring boundary conditions) conforms to the binomial distribution. In other cases, analysis of data collected in the course of certain recent crop surveys (again ignoring boundary conditions) show a more generalized type of distribution, in which the variance is inversely proportional to a constant power of the size of the sampling unit. This result enables the field characteristics being defined with the help of two parameters.

The efficiency of a sampling programme depends on two factors, namely, the magnitude of the sampling error and the total cost or time necessary for the sampling work. The result given in the previous paragraph determines the sampling error. The second factor can be studied by constructing suitable cost functions which depend on the size of the sampling units as well as on their density. The efficiency of sampling can then be suitably defined in terms of the variance function and the cost function. Maximizing this expression in the usual way it is finally possible to determine the most efficient sampling programme for a given expenditure for different types of field.

18. The distribution of the studentised D^2 statistic appropriate to any pair out of a given set of k equidispersional populations distinct in sets of means.

R. C. BOSE *and* S. N. ROY, Calcutta.

Suppose we have k multivariate (p-variate) normal populations $\pi_1, \pi_2, \ldots\ldots \pi_k$ with a common dispersion matrix

$$\|\alpha_{ij}\|,\ (i, j = 1, 2, \ldots\ldots p)$$

but different sets of means

$$a_i^{(l)}\ (i = 1, 2, \ldots p\,;\ l = 1, 2, \ldots k\,;$$

i denoting the character and l the sample). Let k samples of

$$\Sigma_1, \Sigma_2, \ldots\ldots \Sigma_k$$

of sizes $n_1, n_2 \ldots\ldots n_k$ be drawn one from each of these k populations with sample dispersion matrices $\left\| a_{ij}^{(l)} \right\|$, and sample means $a_i^{(l)}$, (i, j and l having the same significance and sets of values as before). We can now form a dispersion matrix $\|c_{ij}\|$ from the sample dispersion matrices, where

$$c_{ij} = \left(n_1 a_{ij}^{(1)} + n_2 a_{ij}^{(2)} + \ldots\ldots n_k a_{ij}^{(k)}\right) \Big/ \left(n_1 + n_2 + \ldots\ldots n_k\right).$$

The divergence between any two samples, say the first two, can be measured by a D^2_{12}-statistic in which the pooled estimates of variance from all the k samples are used instead of the pooled estimates from only the two samples concerned.
Thus

$$pD^2_{12} = \Sigma\Sigma c^{ij}\left(a_i^{(1)}-a_i^{(2)}\right)\left(a_j^{(1)}-a_j^{(2)}\right),\ (i, j = 1, 2, \ldots\ldots p),\ c^{ij}$$

being the minor of c_{ij} in the determinant $|\,c_{ij}\,|$ divided by the determinant itself. After using the methods of hyperspace geometry analogous to those used in our earlier paper (The random sampling distributions of the Studentised D^2 statistic read at the Science Congress, 1938) the distribution of D^2_{12} comes out in the two alternative forms

$$(1)\quad \text{Const}\times e^{-\frac{1}{4}p\bar{n}\Delta^2_{12}}\left(D^2_{12}\right)^{(p-2)/2}\left(1+\frac{p\bar{n}}{N}D^2_{12}\right)^{-(N-k+1)/2}$$

$$\times\,{}_1F_1\left(\frac{N-k+1}{2},\ \frac{p}{2},\ \frac{p^2\bar{n}^2\Delta^2_{12}D^2_{12}}{8N+4p\bar{n}D^2_{12}}\right)\cdot d\left(D^2_{12}\right)$$

or

$$(2)\quad \text{Const}\times e^{-\frac{(p\bar{n}\Delta^2_{12})/4}{1+(p\bar{n}/2N)D^2_{12}}},\ \left(D^2_{12}\right)^{\frac{p-2}{2}}.\left(1+\frac{p\bar{n}}{2N}D^2_{12}\right)^{-(N-k+1)/2}$$

$$\times\,{}_1F_1\left(\frac{p+k-1-N}{2},\ \frac{p}{2},\ -\frac{p^2\bar{n}^2\Delta^2_{12}D^2_{12}}{8N+4p\bar{n}D^2_{12}}\right)d\left(D^2_{12}\right)$$

where $\bar{n}$ is defined as

$$\frac{2}{\bar{n}} = \frac{1}{n_1}+\frac{1}{n_2};\ N,\ K,\ p \text{ and } D^2_{12}$$

have been already defined; Δ^2_{12} is the corresponding measure of divergence between the populations (1) and (2) defined by

$$p\Delta^2_{12} = \Sigma\Sigma\alpha^{ij}\left(\alpha_i^{(1)}-\alpha_i^{(2)}\right)\left(\alpha_j^{(1)}-\alpha_j^{(2)}\right)$$

and the constants in both (1) and (2) are the same, viz.,

$$\left(\frac{p\bar{n}}{N}\right)^p.\frac{\Gamma\left(\frac{N-k+1}{2}\right)}{\Gamma\left(\frac{p}{2}\right)\Gamma\left(\frac{N-k+1-p}{2}\right)},$$

It is easily seen that if we put $k=2$, i.e. consider only two populations, then these distributions reduce, as they should, to the distribution in the earlier paper referred to already.

19. On the completely orthogonalized Hyper-Græco Latin Square.

R. C. Bose, Calcutta.

In an earlier paper (*Sankhya*, Vol. 3, Part 4) the writer has shown how the properties of the Galois field GF_{p^n} can be utilized to construct an s-sided completely orthogonalized Hyper-Graeco Latin Square, where s is a prime or a power of a prime, thus proving the correctness of a surmise of Prof. R. A. Fisher. Only the simplest type of square was examined. In the present paper, the properties of finite hyper-dimensional projective geometries are used to enumerate and classify the various types of Hyper-Græco Latin Squares.

20. On the generalized interaction in a $s\times s\times s\times$ . . . . . . $(=s^n)$ factorial arrangement, where s is a prime or a power of a prime.

R. C. Bose *and* K. Kishen, Calcutta.

The properties of finite hyper-dimensional projective geometries allied to the Galois field GF_{p^m}, where $s=p^m$, p being a prime and m an integer, each line passing through $s+1$ points, have been made use of in developing a new concept of generalized interaction between any two main effects or interactions in a $s\times s\times s\times$ . . . . $(=s^n)$ system, each having $s-1$ degrees of freedom. A perfect internal symmetry is revealed in the structure of such a factorial arrangement, so that if any suitably chosen n of the $s^{n-1}+s^{n-2}+$. . . . $.+s^2+s+1$ sets of $s-1$ degrees of freedom each be termed the main effects with corresponding alterations in the designation of the treatment combinations, the remaining sets will denote the interactions.

The possibilities of confounding high-order interactions in a s^n factorial arrangement have been investigated in detail and some useful combinations of sets which may be confounded in a replication have been given. Balanced symmetrical layouts have been also discussed which confound analogous combinations of sets in different replications.

21. Tables of confidence intervals for the median in samples from any continuous population.

K. Raghavan Nair, Calcutta.

William R. Thompson in America and S. R. Savur in India have worked on the Confidence Range of the Median for Samples from any statistical population. The former confines himself to continuous populations while the latter presumably includes discontinuous populations also. Thompson shows that for a sample of size n the probability that the median of the population lies between the lth and $(n-l+1)$th observation, arranged according to size, is

$$1-2\,I_{0\cdot5}\,(n-l+1,\,l)$$

where $I_x(p,\,q)$ is the function tabulated in the *Incomplete Beta-Function Tables.* I have prepared tables of n and l for confidence coefficients in the neighbourhood of 95 per cent. and 99 per cent. The tests of significance for two samples suggested by them have been compared.

22. The use of median statistic in tests by randomization.

K. Raghavan Nair, Calcutta.

R. A. Fisher has developed a test by randomization whereby the assumption of normality can be avoided. E. S. Pearson has shown that this test will control the second kind of error only if the statistic chosen is efficient. When the population form is unknown it is impossible to decide what will be the efficient statistic. It is demonstrated in this paper that judging from the point of simplicity, the Median will be the best statistic to use in test by randomization.

Astronomy, Astrophysics and Atomic Physics

23. Some photographs of regions in the Milky Way, taken with a short focus camera.

T. P. BHASKARA SHASTRI, Hyderabad (Deccan).

An astro-camera with a wide field has recently been acquired for the Nizamiah Observatory, Hyderabad. The objective is a Ross lens of 4¼ inches aperture and focal length about 30 inches. The field of good definition covers nearly an area 5°× 5°. A separate mounting and clock work not being available, the camera has been provisionally mounted on the tube of the astrographic telescope and photographs of regions in and near the Milky Way are taken with an exposure of one hour. A few of the photographs that show features of interest are exhibited. Arrangements are being made to provide the camera with a suitable mounting so that photographs can be conveniently taken with exposures of longer duration.

24. A survey of stars with large proper motion in the Hyderabad Astrographic zones.

T. P. BHASKARA SHASTRI, Hyderabad (Deccan).

A knowledge of proper motions of stars is perhaps one of the most important requirements in connection with investigations on the structure of the stellar Universe. Stars brighter than the ninth magnitude have been observed with meridian instruments over a considerable period and hence proper motions in the case of such stars are known with a fair degree of accuracy. But for the vast number of fainter stars in the sky, the available information is far from complete. As is well known, proper motions of these stars are best determined by comparing photographs of the same region taken at widely separated epochs.

The plates required for the Hyderabad section of the "carte du ciel" were obtained and measured some years ago, and a second series of photographs is being taken with the same telescope for comparison with the plates of the earlier series for determining proper motions. The average interval between pairs of plates is about twenty years. The comparison is made with the Blink Comparator described by the writer at the Hyderabad session of the Indian Science Congress (1937). With some practice, the observers are able to detect easily proper motions greater than 10″ per century, while some smaller motions are also occasionally recorded. The stars showing sensible displacements are marked on the plates at the time of comparison. They are afterwards measured accurately on both the plates with a measuring micrometer, together with twelve comparison stars scattered uniformly over the whole region. The reductions are made in the usual manner and proper motions are determined referred to the mean of the comparison stars employed. 85 plates (centre in Dec. 17°S) have so far been examined with the Blink Comparator. These cover an area of 340 square degrees in the sky. Besides stars of known proper motion (101 in number), 121 faint stars have been discovered with proper motions exceeding 0″·010 per annum. The proper motions derived are analysed with reference to the apparent brightness of stars and the results are discussed in the present note.

25. Levi-Civita's potential function for two bodies.

SIR SHAH SULAIMAN, Delhi.

Prof. Tullio Levi-Civita, accepting the Newtonian conception of absolute space and treating the extra effect in Einstein's equation as a first order perturbation, has deduced certain astronomical consequences of relativistic two-body problem, which in Relativity itself is wholly insoluble. He has found a potential function for two bodies of comparable masses, the trajectory being that of a central force. It is claimed here that his function is wrong. By putting one of the masses as zero and thereby reducing the problem to Einstein's one centre problem, the force function becomes a combination of the inverse square and the inverse cube of the distance. It is then shown that his function is really a solution, not of Einstein's differential equation for orbital motion containing an extra term with the inverse square of the distance, but of a totally different differential equation containing instead the inverse square.

It is also shown that Levi-Civita's function yields only the Newtonian value for the deflection of light from stars past the sun, and not at all the Einsteinian one.

His second conclusion that for a double star there is a net acceleration of the centre of gravity is also challenged.

26. The equilibrium between neutrons, protons, and electrons.

D. S. KOTHARI *and* B. N. SINGH, Delhi.

It is now well established that the mass of the neutron is greater than the combined mass of the proton and the electron by about 0·001 mass unit. An electron to be able to transform a proton into a neutron, must have kinetic energy at least equal to or greater than this value (denoted by U). When degenerate electron-gas is in equilibrium with protons, E^*, the maximum energy of the Fermi-distribution, cannot appreciably exceed U, for the electrons having energy greater than U will combine with protons transforming them into neutrons. As E^* depends only on the electron-concentration it is easily seen that there will exist an upper limit for the free electron concentration (and pressure) for a degenerate electron gas in equilibrium with protons. These ideas have been quantitatively worked out by one of us (D.S.K.) in a recent paper (*Proc. Roy. Soc.*, Oct. 15, 1937).

There is one point, however, where the above considerations need somewhat further examination. In a degenerate gas the number of electrons having energy above E^* is small but is not zero unless at the absolute zero of temperature. The effect of these electrons has been ignored in the paper referred to.

In the present paper we use the general theorem of dissociative equilibrium to work out the equilibrium between neutrons, protons and electrons, and hence the effect of the electron having energy above E^* is automatically taken account of. This is a more rigorous method than that used in the previous paper and leads to some new results. The non-degenerate case is also included. It is found that the ratio of proton to neutron concentration has a minimum value of about 10^{-4} for an electron concentration of about 10^{-32}. A higher or lower electron concentration than the above value gives a larger value of the proton-neutron ratio. Some astrophysical applications are also discussed.

27. The arms of a spiral nebula.

A. C. BANERJI, NAZIMUDDIN, *and* P. L. BHATNAGAR, Allahabad.

In this paper, theories of Jeans, Brown, Vogt, and Lindblad about the formation of spiral arms have been briefly discussed and criticized. In all these theories the structure of the rotating system is taken to be such as does not seem to be in conformity with observed data. The authors have worked out the case of a rotating system which is more in accordance with the conclusions arrived at from observed phenomena. They have taken the rotating system to be a spheroidal nucleus of uniform density

ρ_0 and of equatorial radius $k_0 a$ ($k_0 < 1$) surrounded by compressible gaseous material of variable density whose outer boundary is a similar spheriod having equatorial radius equal to a. k_0 is a numerical quantity which is taken to be comparatively small. At a sufficient distance from the centre of the system the law of density at a point within the compressible material is assumed to be $\rho = \frac{k_0{}^2}{k^2} \rho_0$, where ka ($k < 1$) is the equatorial radius of the similar spheroid passing through the point.

It is found that for formation of the spiral arms the condition given below must be satisfied: viz.,

$$\frac{\omega^2}{2\pi\rho_0} > \frac{2}{3} (1-e^2)^{\frac{1}{2}} [\alpha_0 + \alpha_1 e^2 \ldots + \alpha_n e^{2n}]$$

where ω is the angular velocity and e the eccentricity of the system; and $\alpha_0, \alpha_1 \ldots . \alpha_n$ are numerical quantities depending on k_0. It has also been observed that diffuse matter in space is ionized by general radiation of the stars. It has been found that in the case of heavy arms of a spiral nebula, ionization has the effect of reducing gravitational attraction and hence of opening out the arms.

28. On the gravitational influence of radiation on radiation.

N. R. Sen, Calcutta.

Tolman, Ehrenfest and Podolsky have shown that the velocity of a ray of radiation is not influenced by the gravitational field of a neighbouring pencil of radiation which is supposed to be emitted at one point and finally absorbed at another on its path. This result is indeed independent of the intensity of the pencil generating the field. If, instead of pure radiation, we have a mixture of radiation and a stream of particles moving very swiftly along the pencil, it can be shown that for velocities not approaching the velocity of light, the gravitational field of the mixture influences the velocity of the neighbouring ray to the order of the density of the stream of particles in the pencil. If, on the other hand, the particles have velocities *almost* indistinguishable from the velocity of light, the mixture behaves exactly as pure radiation as regards its gravitational action on the neighbouring ray, which now moves with the fundamental velocity. The conclusion of Tolman, Ehrenfest and Podolsky that in the interstellar space, the light rays do not influence one another gravitationally will thus retain its validity even if we assume interstellar space to be traversed with fundamental particles moving almost with the velocity of light.

29. Angular distributions of emitted particles in nuclear reactions.

P. L. Kapur, Lahore.

This paper deals with the question of the angular distribution of the outgoing particles in nuclear reactions, especially by thermal neutrons. It is commonly accepted that for slow bombarding particles, partial waves with $l=0$ alone contribute and so the distribution should be isotropic. For the distribution to be anything else it is essenital that waves with $l \geqslant 1$ should also contribute; this will be the case if there exist forces extending over 10^{-9} cm. (wave-length of thermal neutrons), but in the present state of knowledge we know such is not the case. The possibility of getting an asymmetrical distribution without postulating any such long range forces is discussed. It is shown on quite general grounds that even though ordinarily waves with $l \geqslant 1$ do not contribute to the process, yet if there exists a resonance level for them, their contribution to the cross section is quite appreciable. The calculations make use of the one-level dispersion formula and a general expression for the partial widths which can be derived in a manner similar to that employed in a previous paper. It is to be emphasized, however, that at the moment the existence of a resonance level does not seem compatible with $1/v$-law.

30. Partial entry of particles through potential barriers.

P. L. KAPUR, Lahore.

When the bombarding particle consists of two or more loosely bound neutrons and protons, its entry through the Coulomb potential barrier of the bombarded nucleus is only partial for energies which are small compared with the height of the potential barrier. In such cases the penetration coefficient comes out to be greater than what it would be if the penetration were complete. For instance, if the bombarding particle were a deuteron the penetrability coefficient would come out to be much greater than what it would have been if the deuteron were one particle with unit charge and mass twice the mass of a proton. This finds a simple physical explanation in the fact that it is only the proton constituting the deuteron which is affected by the Coulomb repulsion while the neutron is immune from it. This results in the neutron getting into the nuclear core and bringing about the reaction while the proton is repelled away.

31. Entropy of Fermi-Dirac gas.

F. C. AULUCK.

Entropy of Fermi-Dirac gas is found up to the second order of approximation in this paper. All the cases, in which the electron gas behaves like a degenerate or non-degenerate gas, are considered.

32. The internal constitution of white dwarf stars and the planets.

F. C. AULUCK.

In the interior of white dwarf stars and the planets the condition of degeneracy is satisfied. The degree of ionization in cold matter depends upon the density or pressure, as shown by Kothari. The mean molecular weight μ per free electron is a function of ρ. Hence in Emden's equation it is not legitimate to consider μ as a constant but its value as given by the theory of pressure ionization should be used in the equation. This is done in the present paper and its consequences worked out.

Physics of the Atmosphere and Meteorology.

33. The fringe of the outer atmosphere.

S. K. MITRA, Calcutta.

The atmosphere above the surface of the earth may be considered as divided into three regions—the inner adiabatic region (troposphere), the outer isothermal region (stratosphere) and the "fringe" or the "spray" region beyond the outer atmosphere in which gas molecules move without collision. The distances up to which these various regions extend have been calculated by various authors on the assumption that the outer atmosphere consists mainly of hydrogen and helium. The limit of the isothermal outer atmosphere, within which gas kinetic collisions are appreciable, is, according to Milne and to Jones, 1,541 km. for hydrogen and 650 km. for helium. These heights are also the heights at which escape of molecules from the interior of the outer atmosphere begins. In the "fringe" or the "spray" of the atmosphere the molecules move practically without any collision and describe orbits of enormous dimensions round the earth. This "fringe" or "spray" region of the outer atmosphere has recently been receiving considerable attention owing to the fact that attempts are being made to explain the origin of Aurora Borealis, and also of the terrestrial magnetic variations by considering the motion of ionized molecules of this region under the influence of the terrestrial magnetic field. It is therefore important to estimate the height and the physical conditions of the spray region in the light of our newer knowledge regarding the state of the outer atmosphere.

It is now known that contrary to the view held before, the outer atmosphere above 100 km. level consists mainly of atomic oxygen and molecular nitrogen and also that the temperature in this region is considerably higher (about 1000°K) than hitherto believed. Taking these facts into consideration and also by taking the 100 km. level (at which the temperature, pressure and composition are known to a fair degree of approximation) as the datum level, Mr. A. K. Banerjee working in my laboratory has calculated the height at which the "fringe" or the "spray" of the outer atmosphere should commence. For atomic oxygen, the level of commencement lies between 770 km. and 930 km. and for molecular nitrogen between 510 km. and 586 km.

34. On the intensity of the ionization in the earth's atmosphere.

A. C. Banerji *and* P. L. Bhatnagar, Allahabad.

Chapman has calculated the rate of ion production and absorption of radiation in the earth's atmosphere. He has assumed that the isothermal condition prevails throughout the atmosphere, and has not taken account of variation of gravity. It is known that adiabatic region in the earth's atmosphere extends up to 11 km. above sea-level, over which the atmosphere is in isothermal state. Now ionized layers are also found at a height of 300 km. and above, and at such heights variation of gravity cannot be totally neglected.

In this paper the authors have calculated separately the rate of ion-production in the adiabatic region and also in the isothermal region above it, the variation of gravity also being taken into account.

35. Spectroscopic determination of the amount of ozone in the atmosphere over Bombay.

M. W. Chiplonkar, Bombay.

Dobson and others have determined the ozone content of the atmosphere in different parts of the world. In Europe, they have also determined the ozone content under different meteorological conditions. Dobson's data include values for Kodaikanal in S. India for a period of one year. The Kodaikanal data did not indicate any dependence of ozone content on the season. With a view to studying more closely the possible seasonal and inter-diurnal variations of ozone content in a region where the contrast of seasons is more marked than in Kodaikanal, measurements of ozone content were commenced at the Bombay Observatory in October 1936 and have been continued since then. The Bombay data show marked seasonal variations, there being two maxima in the year, one in February and the other in October. The minimum in the monsoon season June, July, August is much more marked than the one in November, December. The mean monthly values range from 0·18 to 0·22 cm. of ozone at N.T.P. It is probable that the total amount of ozone in the atmosphere decreases with the increase of moisture content in the upper part of the troposphere.

36. On the brightness of the zenith sky during twilight on clear evenings and the variation of temperature with height in the upper atmosphere.

M. W. Chiplonkar, Bombay.

A visual photometer is described for measuring the brightness of the zenith sky during twilight. The results of measurements made with it at Bombay on a large number of clear moonless evenings during the period December 1937 to March 1938 are discussed. A red filter RG_1 (Schott and Gen.) and a green filter VG_1 (Schott and Gen.) were used. With the latter, it was possible to continue observations even when twilight conditions had completely ceased. The variations in brightness agree with a relation proposed by Link, namely, $dI/I = \frac{\beta \sin \theta d\theta}{\cos^2 \theta}$, where I is the brightness of the zenith sky, θ the angular depression of the sun below the horizon and β a constant. If the brightness is due only to primary scattering from the atmosphere illuminated by sunlight, it is possible to connect β with the temperature of the atmospheric layer responsible for the scattering. The difficulty however is to ascertain to what extent, secondary scattering is important. For estimating its amount, the absolute brightness of the zenith sky was compared with what might be expected theoretically from primary scattering alone. The secondary scattering is found to be so strong compared with the primary, that reliable conclusions about upper air temperatures are not possible.

37. Relationship between upper wind velocity and temperature.

S. K. Banerji, Poona.

If the axes of x, y, z be drawn towards east, north and vertical direction respectively, and if u, v, w be the components of velocity, the equations of motion, neglecting the viscosity, can be expressed in the form

$$\frac{\partial u}{\partial t}+\frac{1}{2}\frac{\partial}{\partial x}q^2+\beta w-\gamma v=-\frac{1}{\rho}\frac{\partial p}{\partial x},$$

$$\frac{\partial v}{\partial t}+\frac{1}{2}\frac{\partial}{\partial y}q^2+\gamma u=-\frac{1}{\rho}\frac{\partial p}{\partial y},$$

$$\frac{\partial w}{\partial t}+\frac{1}{2}\frac{\partial}{\partial z}q^2-\beta u=-g-\frac{1}{\rho}\frac{\partial p}{\partial z},$$

where $\beta = 2\omega \cos \phi$, $\gamma = 2\omega \sin \phi$, $q^2 = u^2+v^2+w^2$,

ω being the angular velocity of the earth and ϕ the latitude. Assuming a steady condition and neglecting vertical motion as well as the square of the velocity, and taking $\cos \phi=0$, Sir Napier Shaw deduced the following relationships between the horizontal components of velocity and temperature T,

$$\frac{\partial}{\partial z}\left(\frac{v}{T}\right)=\frac{g}{\gamma T^2}\frac{\partial T}{\partial x},\quad \frac{\partial}{\partial z}\left(\frac{u}{T}\right)=-\frac{g}{\gamma T^2}\frac{\partial T}{\partial y}.$$

These assumptions are not always justified particularly in tropical regions. It is, therefore, little wonder that the correlation coefficient between the observed variations of temperature and those predicted by these equations has been found to be low, little less than 0·5, even in high latitudes. In low latitudes, the assumption $\cos \phi = 0$ completely invalidates the equations. Moreover, the vertical velocity, even though small compared with the horizontal, makes a very large contribution to temperature variation, and cannot, therefore, be neglected in such equations.

In the atmosphere we seldom see a steady state. To take account of the non-steady state, we can assume either

$$u = \lambda t + u_0,\quad v = \mu t + v_0,\quad w = \nu t + w_0 \quad \text{or} \quad u = u_0 e^{\lambda t},\quad v = v_0 e^{\mu t},\quad w = w_0 e^{\nu t},$$

where λ, μ, ν are functions of x, y, z, real or imaginary. We got in the case of the second assumption

$$\frac{g}{T^2}\frac{\partial T}{\partial x} = -\beta\frac{\partial}{\partial x}\left(\frac{u}{T}\right) - \frac{\partial}{\partial z}\left(\frac{\lambda u}{T}\right) + \gamma\frac{\partial}{\partial z}\left(\frac{v}{T}\right) + \frac{\partial}{\partial x}\left(\frac{vw}{T}\right)$$
$$-\beta\frac{\partial}{\partial z}\left(\frac{w}{T}\right) + \frac{1}{2}\frac{\partial}{\partial x}\left(\frac{1}{T}\frac{\partial q^2}{\partial z}\right) - \frac{1}{2}\frac{\partial}{\partial z}\left(\frac{1}{T}\frac{\partial q^2}{\partial x}\right),$$

$$\frac{g}{T^2}\frac{T}{y} = -\beta\frac{\partial}{\partial y}\left(\frac{u}{T}\right) + \gamma\frac{\partial}{\partial z}\left(\frac{u}{T}\right) - \frac{\partial}{\partial z}\left(\frac{uv}{T}\right) + \frac{\partial}{\partial y}\left(\frac{vw}{T}\right)$$
$$+\frac{1}{2}\frac{\partial}{\partial y}\left(\frac{1}{T}\frac{\partial q^2}{\partial z}\right) - \frac{1}{2}\frac{\partial}{\partial z}\left(\frac{1}{T}\frac{\partial q^2}{\partial y}\right).$$

For the first assumption, the equations are obtained by writing λ, μ, ν for λu, μv, νw respectively in the above equation.

If the motion is steady, $\lambda = \mu = \nu = 0$, and if the vertical velocity and the square of the velocity can be neglected, $w=0$, $q=0$. Therefore, we get,

$$\frac{g}{T^2}\frac{\partial T}{\partial x} = -\beta\frac{\partial}{\partial x}\left(\frac{u}{T}\right) + \gamma\frac{\partial}{\partial z}\left(\frac{v}{T}\right), \quad \frac{g}{T^2}\frac{\partial T}{\partial y} = -\beta\frac{\partial}{\partial y}\left(\frac{u}{T}\right) - \gamma\frac{\partial}{\partial z}\left(\frac{u}{T}\right).$$

These reduce to Sir Napier Shaw's equations when $\beta = 0$.

Some application of these more general equations to predict the temperature gradient from the known distribution of upper wind velocity over Indian area, with special reference to the field of a cyclone and anticyclone, is given in the paper.

38. A study of stability of atmospheric strata.

S. L. MALURKAR, Karachi.

Hales applied the theory of Rayleigh and Jeffreys to study stability of layers of atmosphere under different lapse-rates. He deduced the maximum lapse-rates that could subsist corresponding to the thickness of the strata. But in this deduction the distribution of temperature was taken as linear. The author has shown previously that the criterion of stability is also very much dependent on the actual temperature distribution and that the actual temperature difference between the top and bottom layers of a fluid layer when the lower surface is heated, could be much more when the temperature curve was concave upwards than if it was linear. In nature it is often found that the temperature distribution is far from linear. The atmospheric problem has the additional complication that the density in the fluid layer is changing. But taking account of this density it is found that the fundamental equation on whose solution the problem is dependent is the same as for a thin layer fluid. It follows that the actual temperature difference that can be found without instability between two levels of the atmosphere is greater or less than that found by Hales if the temperature-height curve is concave upward or concave downwards than if a linear temperature-height curve existed.

39. Changes of atmospheric electric potential gradient associated with monsoon rains in Bombay.

A. R. PILLAI, Bombay.

The changes of atmospheric electric potential gradient accompanying rainfall in the monsoon months are generally much simpler in character than those associated with thunderstorms. The present note contains the results of an analysis of the change in potential gradient with rainfall observed at the Colaba Observatory, Bombay, during June to September in 1937 and 1938. The potential gradient either becomes negative or shows a tendency to become negative in more than 70 per cent of the cases of rainfall. In 5 per cent of the cases the rain had the effect of increasing the positive gradient. In 2 per cent of the occasions, the potential gradient became negative even though no rain was recorded at the Observatory. Typical curves of the variations are shown.

40. Rainfall in the Punjab.

J. B. SETH, Lahore.

From the data of rainfall in the various districts of the Punjab available in 1863, Mr. Edward Prinsep, the then settlement officer of the Amritsar district, concluded that 'gradations of rainfall (in the Punjab) are susceptible of being ranged into Zones running parallel with the Himalayas'. This conclusion has been examined in the light of rainfall data compiled by the Indian Meteorological Department and published in the Indian Meteorological Memoirs.

41. Experimental aeroplane soundings with meteorograph over Karachi.

P. R. KRISHNA RAO, Karachi.

Successful trials were made to obtain autographic records of temperature, pressure and relative humidity by sending up a Bosch-Cannegeiter meteorograph on R.A.F. aeroplanes at Karachi (Drigh Road). A suitable method of mounting the meteorograph inside a metal framework (luggage-rack) fixed to the undersurface of the aeroplane wing was developed with the assistance of the R.A.F. It was found that the obtaining of a satisfactory record not only depended on proper mounting of the instrument but also on the type of plane used and other factors. The records showed that they yield more detailed information than would be available by eye observations at definite heights, specially as regards the structure of the inversions of temperature which are a prominent feature of the upper air over Karachi during April to September. A few interesting records have been obtained.

42. Diurnal variation in the temperature and humidity distribution up to 3 km. over Karachi.

P. R. KRISHNA RAO, Karachi.

The diurnal variation in the temperature and humidity distribution up to 3 km. over Karachi has been studied with the help of observations provided by the R.A.F. from aeroplane meteorological flights made 3 to 5 times daily on some days in 1929, 1930, 1937 and 1938. During October to March, the diurnal variation is influenced mainly by the early morning surface inversions, extending up to about 2,000 feet, which disappear by about 10 A.M. but re-appear after about 7 P.M. The diurnal range is maximum at the surface and decreases rapidly with height up to about 0·6 km. above which it is very small. During April to September the diurnal variation is prominent up to about 1·5 km. and is influenced mainly by the diurnal changes in the height and intensity of the temperature inversions which occur frequently between 0·5 and 1·5 km. in the transition region separating a lower layer of moist cold sea air and very much drier and warmer air above. The diurnal range of temperature and relative humidity decreases with height up to the region where inversions commence and increases again for some height in the inversion region to decrease later towards the upper portions of the inversion. The diurnal range in some parts of the inversion region is sometimes larger than at the surface.

43. Fog at Karachi Air Port, Drigh Road.

P. R. KRISHNA RAO, Karachi.

A study of fogs occurring at aerodromes and their forecasting is of great importance for aviation. Fogs at Karachi Air Port, Drigh Road, during 1929–1936, have been studied. About 12 fogs occur in a year during October to May. Most of them are thick ones in which visibility falls below 220 yards and sometimes below 10 or 15 yards. They generally commence between 5 and 7 A.M. within about 2 hours before sunrise and clear between 7 A.M. and 9 A.M., generally about 1 to 1½ hours after sunrise. Relative humidity in fogs is generally above 95 per cent., unsaturation fogs with less than 90 per cent. humidity being very rare. Available evidence goes to show that the most predominant type of fog is the 'radiation ground fog' and occurs in weather situations when there is a shallow low pressure area over Sind with feeble pressure gradient over lower Sind and also in feeble anticyclonic weather situations. The moisture for fog is provided by the sea breeze which penetrates inland on the previous afternoon. Light katabatic winds draining down from the hill-slopes towards the N. and N.E. appear to assist in the formation of fog. Fogs are generally about 200 to 300 feet deep and the horizontal extent is about 5 miles. Taylor diagrams were constructed for the different periods of the fog season based on 14 G.M.T. readings of dry and wet bulb temperature. The diagrams are by themselves not a completely successful aid in forecasting but used in conjunction with a synoptic chart they are of some assistance in forecasting, specially in ruling out days on which fog is not likely.

44. On forecasting of weather over south Bengal during the nor'wester season, mid-March to mid-May.

A. K. ROY, Poona.

An empirical method of day-to-day forecasting of thunderstorm rain in south Bengal during the period, mid-March to mid-May, based on barometric pressures at 0800 hr. local time at three stations in south Bengal is suggested. An examination of data for six years, 1929 to 1934, shows that on days on which pressures at Barisal and Berhampur were both higher than the pressure at Calcutta, rain occurred in South Bengal on about 79 per cent occasions. Further, when Berhampur pressure minus Calcutta pressure was +·03″ or more, with Barisal registering higher pressure than Calcutta, rainfall occurred in south Bengal on 97 per cent occasions.

45. The thermal structure of the air layers near the ground at night during clear weather in relation to other meteorological factors.

L. A. Ramdas, Poona.

Observations of air temperature at different levels above ground have been recorded daily at the Central Agricultural Meteorological Observatory at fixed times. The paper gives a discussion of the thermal structure of the air layers near the ground at the *minimum temperature epoch* during the clear season. There is a region of positive lapse rate (temperature decreasing with height) starting from the ground which ceases at some distance above the ground. Thereafter, the lapse-rate is zero for a little distance upwards. Then begins the well-known inversion or region of negative lapse-rate. The thickness of the layer of zero lapse-rate, the lapse-rates above and below it and the relation of these quantities to other contemporary phenomena like wind velocity, moisture in the atmosphere, etc. are discussed.

46. Vertical currents in the first few kilometres over Poona and their possible effect on the measures of upper winds made by pilot balloons assumed to rise at a known constant rate.

K. P. Ramakrishnan, Poona.

The height-time curves of both morning and afternoon pilot balloon ascents at Poona on a large number of days in May and November 1937, determined by the tail method are compared with those calculated from the usual formula. For a few of these ascents, the winds worked out from the two sets of height values are compared. The method of calculation of winds is examined and it is shown that no simple correction can be applied to the wind values so as to allow for the effect of vertical currents.

A statistical comparison has been made of one year's data of the rates of ascent in the first 4 km. obtained by the tail method and by the above formula. It is found that the two rates agree well in the mornings, while in the afternoons, wide variations occur, which on the aggregate, amount to an excess of rate of about 12%, the increase being more pronounced in the months February to June.

Brief résumé of previous unpublished work on the subject done by Das and Kanade is given. In an appendix, it is shown that errors due to slant of tail cannot account for as much deviations as actually occur.

47. Inter-diurnal variability of pressure and temperature at different levels over Agra in N. India during the period November to April.

M. W. Chiplonkar, Bombay.

The paper contains an analysis of the day-to-day variability of upper air temperatures and pressures over Agra during the winter and early hot season months November to April. The day-to-day differences of pressure and temperature are analysed under three groups : (1) when the change of surface pressure is positive, (2) when it is within ± 0·5 mb., and (3) when it is negative. The day-to-day differences at different levels are averaged (1) taking the signs of the changes into account and (2) ignoring the signs and taking the arithmetic means. Similar averaging is carried out taking the datum levels as 2 km. and 4 km. One of the interesting results of the analysis is that while on the average, a positive or negative change of pressure at 2 or 4 km. signifies a change in the same direction at levels up to

14 km. a positive or negative change of pressure which is observed at the surface is not associated with similar changes except to a small height. A change of pressure at a 2 km. station is therefore a more significant indication of atmospheric change than a similar change at a low level station.

Spectroscopy.

48. On the identification of the Sun-spot line at λ 6708A.

S. DATTA *and* G. KARMAKAR, Calcutta.

There had been some controversy about the identification of the line at λ 6708, which appears only in the spot and not in the spectrum of the disc, some holding it due to calcium and other to lithium. Eventually when Charlotte Moore observed it as a doublet in the spot spectrum having the same separation as the lithium doublet, the line was accepted as due to lithium, although some doubts remained as the observed spot intensity leads one to expect the line in the disc spectrum as well. The question was, however, reopened by Datta and Bose in 1935, when they observed a fairly strong line at λ 6708 without the accompaniment of any other lines of lithium by feeding carbon arc which contained calcium as an impurity, sparingly with rubidium.

In the course of the present investigation, several experiments have been performed which seem to indicate that at λ 6708, in very close proximity there are two lines, one due to lithium (λ 6707·08) and the other due to calcium (λ 6707·84) both unresolved in the instruments at our disposal. The line due to calcium appears in the flame part of the arc and disappears in the core and thereby conforms to the main characteristic of the solar line, viz., it appears in the spot and not in the disc. As the line due to lithium does not similarly behave the present results lead to the conclusion that lithium may not be present in the sun.

It has not however been possible to fit the line into the existing scheme of classification of the calcium lines and hence there remains the possibility of the line arising out of some other impurity such as barium or strontium which may be present in calcium. Further investigations are at hand to settle this question.

49. Note on a change in the transition probability of sodium atoms in absorption.

S. DATTA *and* G. KARMAKAR, Calcutta.

It is well-known that the intensity of absorption of a particular line is dependent on: (1) the probability of the corresponding transition, (2) the number of atoms which are available for taking part in the transition. As the transition probability has a relation only with the eigenfunction of the atoms in the states involved in the transition, it is regarded to have a constant value for each particular transition.

In course of an experiment on absorption of light by sodium vapour it was found that the coefficient of absorption of the 2nd and 3rd member of the principal series showed a decided decrease according as a filter was used or not for removing from the source radiations corresponding to the 1st member of the principal series. The experiment was repeated at different pressures and same decrease was observed in every case.

This result is rather surprising, as the use of the filter stopping the first transition is conducive to allowing more number of atoms taking part in other transitions. Hence if the filter has any effect at all one might expect an increase in the absorption coefficient rather than a decrease. The results obtained here, if they are substantiated on repetition of the experiments with other vapours, would undoubtedly lead to the view that the transition probability may not after all be as much independent of one another as is thought of and somehow or other successive transitions of a series are stimulated by the preceding ones.

50. The higher spark-spectra of iodine I(VI) and I(VII).

R. Sanjivarao *and* S. G. Krishnamurty, Waltair.

With a view to identify the important multiplets due to Iodine VI and VII, the data recently published by Prof. Bloch were examined. Making use of the usual doublet laws of Millikan, it was possible to identify the main $5p\ {}^3P\text{-}5p^2\ {}^3P$, and $5p\ {}^3P\text{–}5p^2\ {}^3D$ multiplets in I VI and the $5p\ {}^2P$ $5d\ {}^2D$ in I VII spectra. The assignments are quite in keeping with the results of other workers in other homologous spectra.

51. The higher spark-spectra of iodine I(V).

S. G. Krishnamurty *and* R. Sanjivarao, Waltair.

The spectrum of a highly condensed discharge through the vapour of iodine contained in the usual H-type discharge tubes was photographed by using a large quartz Littrow spectrograph. Two very intense lines occurring in the quartz region, were identified to be due to the spectrum of IV. Starting with this pair as the basis and making use of the data in the Schumann region due to Prof. Bloch, the important doublets $5p^2$ ${}^2D\text{–}5p\ {}^2P$ due to IV were located. These embraced about twelve terms.

52. Continuous spectrum of helium.

P. K. Kichlu, Lahore.

Exact experimental conditions for the production of the strong continuous spectrum of helium between 500Å and 1000Å are described. The question of the association of maxima in this spectrum with the visible bands of helium which invariably accompany them is discussed.

53. Absorption spectrum of cadmium by the excitation of inner electrons.

P. K. Kichlu *and* B. M. Anand, Lahore.

The absorption spectrum of cadmium vapour in the region 600Å—1000Å is studied with a normal incidence vacuum grating spectrograph. Helium continuum was used as the background and an isolated circulatory system was employed for the purification of the gases generated during discharges. Full details of the technique employed are given. The following series lines in absorption were recorded:—

$$4d^{10}\ 5s^2\ {}^1S_0 \rightarrow 4d^9\ 5s^2\ (np\ {}^1P_1\ {}^3P_1\ {}^3D_1,\ nf\ {}^1P_1\ {}^3P_1).$$

54. Absorption of bismuth vapour between 600 Å and 900Å.

P. K. Kichlu *and* B. M. Anand, Lahore.

An arrangement similar to the above was used for obtaining the absorption lines of bismuth vapour between 600Å and 900Å. Helium continuum was employed and the absorbing vapour was generated in a quartz tube heated to about 1000°C. A number of lines have been photographed, but their classification has not yet been completed.

55. Absorption of active-nitrogen in the Schumann region.

MELA RAM, P. N. KALIA *and* B. M. ANAND, Lahore.

According to present day theories active-nitrogen consists of nitrogen atoms in the metastable states $2p^3\ ^2D$, ^2P. If this is so, we should get the lines originating from ^2P and ^2D in absorption. To test this point, experiments were carried out to observe the absorption spectrum of active nitrogen in the Schumann region with a vacuum spectrograph. Continuous spectrum of hydrogen was used as the background. None of the expected lines appeared, but a number of bands of CO and NO were recorded between 1388 Å and 2200 Å. in emission.

56. Production of hydrogen Lyman series.

B. M. ANAND, Lahore.

Weakly condensed discharges are passed in helium at various pressures extending up to 7 mm., containing hydrogen in extremely small quantities, and the effect on the development of hydrogen Lyman series is studied with a vacuum grating spectrograph. Under suitable conditions, it is easy to record the 14th or 15th member in the second order without any difficulty.

57. Production of the spectra of antimony in a hot hollow cathode.

TIRATH RAM *and* TARA CHAND, Lahore.

The cathode in the form of a graphite tube was put at the centre of a large size spherical bulb provided with an anode and side tubes for the inlet and outlet of helium, which was kept circulating at a known pressure by means of a mercury pump. Suitable liquid air traps and charcoal tubes were inserted for purification. Rectified currents up to 400 milliamperes and 4,000 volts could be used. General conditions of the discharge are described and lists of spectra in different stages of ionisation as they appear, are given.

58. Predissociations in the bands of CuCl.

R. K. ASUNDI *and* ASRAR HUSSAIN, Aligarh.

It is found that most of the bands observed in absorption are also present in the flame spectrum of copper chloride, so far as the *C*, *D* and *E* systems are concerned. In the *A* system, though the bands are obscured by the overlapping continuum, only the (0, 0) band is prominent with the possible presence of (1, 0) band which is very diffuse. This probably indicates predissociation of the molecule at this level which lies at 19404 cm.$^{-1}$ The *B* system is represented only by (0, 0) and (0, 1) bands which are both very sharp. This fact definitely points to predissociation occurring in the system at levels higher than $v' = 0$. The exact point of predissociation cannot obviously be located with certainty on these data, but it must lie between 20480 cm.$^{-1}$ ($v' = 0$) and 20877 cm.$^{-1}$ ($v' = 1$ level). The difference in energy, therefore, between the two predissociations in *A* and *B* systems lies between 1076 and 1473 cm.$^{-1}$. The doublet separation in the ground state of Cl being 881 cm.$^{-1}$ it is possible that the above difference is due to the two repulsive curves (non-parallel) which involve a Cl atom in $^2P_{3/2}$ and $^2P_{1/2}$ respectively. These considerations allow us to derive a value of 2·3 *e* volts for the energy of dissociation of the molecule in the ground state.

59. The flame spectrum of copper bromide.

R. K. ASUNDI *and* M. M. AZIZ, Aligarh.

The spectrum which exhibits bands due to CuBr shows two points of predissociation which are approximately at 24608 cm.$^{-1}$ and 21360 cm.$^{-1}$, in the two band systems $C-X$ and $B-X$ respectively. The difference in energy between these two points (3248 cm.$^{-1}$) is correlated with the doublet separation (3685 cm.$^{-1}$) of Br atom in its ground state. Assuming that the ground state of the molecule and the lower repulsive curve arise from unexcited atoms, the energy of dissociation of the molecule in the ground state is shown to be 2·5 *e.* volts.

60. Flame spectra of some salts of alkaline earths.

B. K. VAIDYA, Bombay.

The familiar Bunsen flames of calcium and strontium salts have been photographed in the first order of a 10 foot grating. By the use of a special device which fed the flame continuously all round with a fine spray of the salt, good photographs were obtained on a hypersensitised film after six hours' exposure. The salts employed were chlorides and nitrates.

Some of the systems of bands shown on the chloride pictures are the same as those recorded previously by Hedfled (*Zs. f Phys.*, 68, 610, 1931) and Parker (*Phys. Rev.* 47, 349, 1935), in acetylene flame and in arc respectively, and ascribed by them to Ca-Cl and Sr-Cl molecules. However, there are other well-defined bands in the red and the orange regions in the spectra or both chlorides and nitrates which have not been recorded before, except the part of a short orange system in strontium (salts λ 6101 Å), which has been wrongly attributed to Sr-Cl molecule by Parker. These bands are now suggested to be due to Ca-O and Sr-O molecules. A diffuse but intense system given by calcium salts in the green region (λ 5541Å) and by strontium salts in the orange (λ 6059 Å) have been tentatively attributed to Ca_2 and Sr_2 molecules respectively.

61. Variation of the relative infra-red content of the solar radiations at Bombay.

N. R. TAWDE, Y. G. NAIK *and* V. D. DESSAI, Bombay.

By using a thermopile in conjunction with a sensitive galvanometer, a study of the energy content of the far and near infra-red portions of the sun's spectra has been made. No dispersing system has been employed, but a particular band has been isolated by using requisite filters. The ratio of this energy with the total energy of the sun at any particular time has been evaluated. Observations extended over two days of about 5 hours each show that the relative ratio percentage of the far or near infra-red remains practically constant during the period of peak intensity (11 A.M. to 4 P.M.). Utilizing the previous data of Tawde, Trivedi and Patel on the ultra-violet, a rough estimate has been made of the relative proportions of the solar radiations in the far infra-red, the near infra-red, the visible and the ultra-violet portions.

62. First positive bands in high temperature arc.

N. R. TAWDE *and* V. D. DESAI, Bombay.

Attempt has been made to study the first positive bands of nitrogen in the arc of a point-o-lite lamp whose temperature within the region of the arc is expected to be of the order of nearly 3000° K. So far no study of those bands at higher temperature of this order is available and it was thought also desirable to undertake this work in view of the investigations of Kaplan on these bands. We have made comparison of these bands with those of the positive column of an induction coil discharge in a narrow capillary and found that the distribution of intensity has peculiar characteristics which are likely to be similar to high pressure discharge.

Electric discharge through gases and related phenomena

63. The ultra-high frequency dielectric constant and electrical conductivity of ionized air in a discharge tube.

S. R. KHASTGIR *and* SHAH MD. FAZLOR RAHMAN, Dacca.

In the present investigation, measurements of the ultra-high frequency electrical conductivity and the dielectric constant of the ionized air in a discharge tube having different pressures were undertaken for various values of the tube current from 0 to 17 m.a. The electrical conductivity was found to increase with the increase of the tube current. The measured conductivity was an overall average conductivity due to the presence of both electrons and positive ions. The collisional frequency of the electrons was computed with the help of Chapman and Milne's table from a knowledge of the pressure inside the tube. With this value of the collisional frequency and the measured value of the conductivity as applied to the standard formula, the average electron density was calculated, neglecting the positive ion contribution. The electron density for each different tube current was also determined independently by Langmuir's probe method. This value gave the concentration of the core of uniform discharge near the probe electrode and was found to be greater than the average electron density calculated from the conductivity value. No attempt was made to avoid or eliminate the effect of the positive ionic sheath on the glass wall of the discharge tube. Partly on account of the formation of ionic sheath and partly because the diameter of the electrode was slightly smaller than the diameter of the discharge tube, the discharge was not uniform throughout the cross-section of the tube, specially for higher pressures and smaller tube currents. This explained why the average electron-density was found smaller than the electron density determined by the probe method.

As had previously been observed, the dielectric constant of the ionized air which was less than unity was found to decrease with the increase of the tube current up to a certain value of the latter, beyond which the dielectric constant gradually attained the value of unity and subsequently became greater than one with further increase of tube current. Experiments were performed with *external* condenser plates round the discharge tube having a range of pressures 2 mm. to ·02 mm. of mercury. The experimental results support the theory that the anomalous value of the dielectric constant are due to the formation of a positive ionic sheath on the inside surface of the discharge tube.

64. The dielectric constant and electrical conductivity of gases and vapours ionized by X-rays at ultra-high radio frequency.

S. R. KHASTGIR *and* SHAH MD. FAZLOR RAHMAN, Dacca.

In the present investigation Barton and Kilby's experiments were performed with a different arrangement of apparatus. The terminal condenser of a horizontal pair of Lecher wires into which ultra-high frequency oscillations were induced was filled with gas or vapour at a definite pressure. Length adjustments on the Lecher system for maximum voltage across the terminal condenser and also for current resonance were made by sliding a short-circuiting bridge across the Lecher wires—suitable arrangements having been made with a valve detecting unit to indicate the resonance point. The gas or vapour under test was ionized by X-rays from a Coolidge tube. The shift of the voltage or current resonance point on ionizing the gas or vapour was then carefully studied for four different gases and vapours, viz., air, sulphur dioxide, argon and a mixture of methyl iodide and ethyl bromide. In all the cases, however, a *positive* shift was observed. The shift was found gradually to diminish with the reduction of the X-ray intensity. Again on varying the pressure of the gas or vapour and keeping the intensity of X-rays fixed, the shift was found to be independent of the pressure. These results indicated that there must be a diminution in the effective dielectric constant of the gaseous medium or ionization. This change in the dielectric constant is possible if it is assumed that the ejected photo-electrons remain in a free state at least for a small part of the time of exposure to X-rays.

The H.F. conductivity of argon and sulphur dioxide ionized by X-rays was measured for different pressures by a suitable resonance curve method. The conductivity was found to diminish with the increase of pressure. This is consistent with the theoretical idea. Since the conductivity values were sufficiently small, the voltage resonance condition was identical with the current resonance condition. The conductivity effect in these experiments would not, therefore, affect the resonance length adjustments when the gas or vapour was ionized.

Once the gas or vapour was exposed to X-rays, it was observed that the resonance length did not revert to the smaller value when the X-rays were blocked by a lead shutter. The effect of the X-rays appeared to persist for a sufficiently long time. The shift of the resonance point on ionization was, therefore, measured each time with fresh gas inside the experimental condenser.

65. 'Chemical clean up' in a positive ray tube.

V. T. CHIPLONKAR, Benares.

'Chemical clean up' in discharge tubes is a well known phenomenon and characterizes a sudden decrease in pressure on starting the discharge. A remarkable instance of it was observed when working with a positive ray tube in which this usual decrease was followed by a subsequent increase in the pressure. In the experiment, pitch vapour dissolved in chloroform was allowed, from time to time, into a discharge tube containing hydrogen. It was noticed that the voltage across the tube, as measured by a Kelvin electrometer, rose rapidly although no change was observed either in the discharge current or the wattage input to the H.T. primary. This is clearly to be ascribed to a 'clean up' since the voltage is an index of the pressure, when the conductivity of the gas remains constant. To restore the pressure, more and more hydrogen was added, when after a few of such additions (at each of which the same increase in voltage was observed though the time rate of increase diminished after each successive addition) a stage was reached when the voltage, after rising to its maximum, automatically fell down again; in one case the cycle was repeated though in a less pronounced manner. Significant changes in the colour of the discharge accompany these fluctuations.

66. Localisation of discharge in a positive ray tube.

V. T. CHIPLONKAR, Benares.

It is known that in an ordinary discharge tube the discharge near the cathode 'localises' to an increasing extent on the surface of the cathode, as one increases the voltage across the tube keeping the other conditions the same. This is ultimately characteristic of the space charge or what is the same thing the radial distribution of the field. One expects to find these effects accentuated, in a positive ray tube, owing to the passage of the fast positive ray particles through the canal. This has been confirmed by a measurement of the radial distribution of the current, by means of a three-ring cathode, with and without the central canal. Observations have been made which tend to show that the cathode fall length-voltage curves are different in the two types of discharge, which, if true, supports the above finding.

67. Ring deposits due to bombardment by positive rays.

V. T. CHIPLONKAR, Benares.

The formation of ring deposits on plates of glass or metals, (Dasannacharya, Chiplonkar, *Sapre Nature 42*, 642, 1934) when bombarded by positive rays, has been studied under a variety of conditions involving perhaps all variations in the experimental parameters like that of the nature of discharge, of the bombarded material, of the nature of the deposit forming material, and form of the anode, etc. The phenomenon was observed in most of these cases. Different gases like oxygen, hydrogen, nitrogen, air, carbon dioxide, mixture of hydrogen and nitrogen in the discharge tube gave very similar deposits; iodine vapour by itself did not give any deposit. In addition to these, certain experiments were designed to differentiate between various *à priori* hypotheses. These are finally discussed with reference to the experimental results obtained in our laboratory, and those of other workers.

68. A new type of Doppler effect in positive rays of hydrogen.

B. DASANNACHARYA *and* G. K. DAS, Benares.

It was known that the Doppler effect in the light emission from the positive rays of hydrogen does not obey the usual formula, namely, $d\lambda/\lambda = v/c$, but that the value of $d\lambda$ actually observed falls short of the value to be expected from the above formula, the more so, as the voltage in the discharge tube which is responsible for the velocity of the particle is raised. In the above formula $d\lambda$ is the change in wave-length from λ due to the velocity v of the light emitting particle and c is the velocity of light. We have been able to show that the relation between $d\lambda$ and v consists of two entirely distinct curves, one holding good for neutral light-emitting atoms which were accelerated in the discharge tube as charged atoms, while the other for neutral light-emitting atoms which owe their origin to particles which were accelerated as charged molecules which later after leaving the field in the discharge tube dissociated into a neutral and a charged atom. At higher voltages it is the latter type that completely determines the maximum Doppler displacement and for low voltages, the former. The transition from the one curve to the other occurs at 5,500 volts for H_β and 3,500 volts for H_γ. The two sets of curves are linear. The line corresponding to Doppler effect for low voltages will represent what may be called the normal effect, that for higher voltages the anomalous effect and the transition will represent the new effect in which the Doppler effect is independent of voltage. This effect corresponds to the Paschen-Back effect connecting the normal and anomalous Zeeman effects.

69. The Doppler effect with positive rays of mercury.

B. DASANNACHARYA *and* G. K. DAS, Benares.

The mercury line 4358 Å has been investigated up to 30 kilovolts and is found to give a normal Doppler effect. Although mercury atoms are known to be present in positive rays with multiple charges, the Doppler effect of the above line under the working conditions, namely admixture with hydrogen, corresponded to singly ionized atom.

70. The counting in Geiger point counter.

B. DASANNACHARYA *and* A. C. SETH, Benares.

It was shown by B. Dasannacharya and T. S. Krishna Moorthy (*Phil. Mag.*, *28*, 609, 1937) that the sensitiveness of the Geiger point counter is considerably diminished when the radiation falls axially through the window of the counter. This is particularly pronounced just above the threshold voltage. The present investigation has shown that this has its origin in the suppression of counts brought about by resistances in the counter circuits. The function of the resistances has been investigated in detail and different types of suppression of counts will be discussed in their relation to the counting capacity of the counter.

71. Mercury arc lamps of exceedingly long life and made of soft glass.

C. DAKSHINAMURTI *and* B. DASANNACHARYA, Benares.

Mercury lamps are made usually in quartz or pyrex, soft glass being considered as unsuitable as such lamps are easily broken due to the large quantity of heat developed while the arc is burning. A report will be given of several types of arc lamps suitable for laboratory use prepared out of soft glass with a life time of many hundreds of hours. They can be run without using cooling devices of any kind. They are based on a study of the characteristics of arc discharges, which will be discussed.

Raman Effect, Association in Liquids and related Subjects

72. Raman spectra of camphor in different solvents.

B. M. ANAND *and* NARAIN SINGH, Lahore.

The Raman spectrum of camphor has been studied in the crystalline state and in its saturated solutions in carbon tetrachloride, carbon disulphide, chloroform, methyl alcohol and acetic acid. The characteristic Raman frequencies of camphor in the solid state are: 512, 653, 1182, 1459, 1738 and 2937 cm^{-1}. When dissolved in the first three solvents about twenty frequencies, including the above are observed. In the last two solvents the number of lines observed is small. Important Raman frequencies are ascribed to the corresponding vibrations in the camphor molecule.

73. Association in formic acid.

P. KOTESWARAM, Waltair.

In continuation of the author's previous work on acetic acid the Raman spectrum of formic acid is studied under different conditions. It is found that, as in the case of acetic acid, there is a dilution shift in the maximum of the $C=O$ band towards higher frequencies. The effect of increase of temperature is not very pronounced, though the $C=O$ band is found to get diffuse and flattened. The changes thus observed are explained as due to the breaking up of the associated formic acid molecules into simpler ones at higher dilutions and at higher temperatures. These changes cannot be due to the formation of hydrates as pointed out by other workers as such a formation should lead to a diminution in the Raman frequency and not to an increase as is actually found in formic and acetic acids.

74. Continuous spectrum in Raman effect.

P. Koteswaram, Waltair.

With a view to determine the nature of the continuous spectrum as commonly noticed in the Raman spectra of various substances, the spectrum of sulphuric acid is studied under different conditions. The variations in the width and maximum of the continuum under different dilutions and with different light filters are discussed. Mixtures of sulphuric acid and nitric acid are studied similarly. It is reported that heating with any oxidizing agent removes the continuum in the acid to a remarkable extent. Experiments on the excitation by monochromatic light obtained with a double monochromator are described.

75. Raman spectra and the structures of PCl_5 and $SbCl_5$.

T. Venkatarayudu, Waltair.

The Raman spectrum of PCl_5 shows 4 lines at 248, 356, 405 and 450 and that of $SbCl_5$ shows also 4 lines at 178, 304, 355 and 399. Their structures are presumably similar.

Given the structure of a molecule, it is possible to predict with the help of group theory, the number and polarization characters of the Raman lines that are to be expected of it. In the present paper several possible alternative structures have been tried for these molecules and are shown to be inconsistent with the experimental results. A tetrahedral structure of the type $[PCl_4]^+Cl^-$ only will account for the results satisfactorily. Such a model will give rise to 4 Raman lines and is in accordance with chemical evidence. (See Mellor, *Inorganic and Theoretical Chemistry*, Vol. 8, p. 1012, 1928).

Data in respect of polarization characters would have thrown further light on the question but are not available.

76. Influence of a fluorescent dyestuff molecule on the polarization of fluorescence of another dyestuff in solution.

S. M. Mitra, Dacca.

It is now a well-known phenomenon that the fluorescence of organic compounds in solution is quenched by the addition of foreign substances with a simultaneous increase in the polarization. This quenching is generally explained as due to the collision of the second kind between the molecules of the excited dyestuff and those of the foreign substance as a result of which the excited molecules come down to the unexcited state without emitting any fluorescent radiation.

The influence of a fluorescent dyestuff on the polarization of the fluorescence of another dyestuff in solution was recently studied in detail and it was observed that the polarization of the fluorescence of a dyestuff (A) was found to decrease instead of increasing with the addition of the foreign fluorescent dyestuff (B). The influence seems to be the same as that observed by increasing the concentration of the dyestuff (A) itself.

77. On the influence of foreign substances on the absorption of the dyestuffs in solution.

S. M. Mitra, Dacca.

The influence of foreign substance, such as KI on the absorption of the dyestuffs in solution is studied in detail and it is observed that in the cases of fluorescein, eosin, magdala red in water solution the foreign substance has no effect on their absorption, provided their concentration be of a certain amount. But when their concentrations are increased beyond that amount the nature of the absorption curves also changes with the addition of the foreign substance.

This limiting concentration is different for the different dyestuffs.

78. Dielectric constants of certain liquids with special reference to dispersion at audio frequencies.

H. R. Sarna, Hashiarpur.

The dielectric constant and resistivity have been measured for α-ethyl-n-propyl alcohol, benzene, and their mixtures of different concentrations. Measurements were made at temperatures between 0° and 60°C., and over a frequency range of the applied field from about 200 to about 2000 c.p.s., special attention being given to the maintenance of a high degree of accuracy.

A capacitance bridge and Wagner's earthing device were used. The source of the alternating power was a beat frequency (heterodyne) oscillator, the bridge balance being determined with the aid of an amplifier and telephones. Special screened transformers were used both for the input to and output from the bridge. The test condenser consisted of a bank of circular brass plates, heavily gold plated. The mounting was specially designed to ensure complete rigidity and good insulation and at the same time permitting easy dismantling and re-assembly.

The alcohol was kept for a number of days with barium oxide, and the benzene with sodium wire before each was distilled. Preacautions were taken to prevent exposing the liquids to the atmosphere.

The pure alcohol and those mixtures having a proportion of alcohol greater than about 5%, all displayed decrease in the dielectric constant with increase of frequency. The change is more marked at the lower end of the frequency range, the value finally becoming nearly constant above 1,000 cycles. It was found that both temperature and degree of drying had marked effect upon the magnitude of the frequency dispersion and upon the resistance.

The effects presumably arise from association and are influenced by its degree; the association itself arising possibly in part from the presence of the remaining small traces of moisture. The typical dispersion curve obtained for α-ethyl-n-propyl alcohol has been compared with the theory of dielectric constant dispersion advanced by Pellat. Calculations have been made, involving the application of the results of Debye theory of radio frequency dispersion of the dielectric constant, to the audio frequency range; in this way an estimate can be made of the order of size of the associated aggregates.

Technical Physics and General Properties of Matter

79. The effect of storage at different relative humidities on the strength and colour of cotton.

N. Ahmad *and* A. N. Gulati, Bombay.

It is common knowledge that cotton loses both in strength and whiteness on storage; but very little systematic work appears to have been done on this subject. An investigation to obtain systematic data both on strength and whiteness, together with the rate of growth of micro-organismal infection, has been undertaken at the Technological Laboratory, Matunga.

Two cottons, Broach Palej and B.D. 8, were selected for this purpose and stored over different relative humidities. Certain difficulties were encountered in the beginning in ensuring the proper humidities but these were eventually overcome and the correct humidities obtained by using solutions of calcium chloride and pure water in properly sealed desiccators.

The results obtained so far indicate that both cottons stored for about four months in an atmosphere of saturated relative humidity (which read only 96% on a dew-point hygrometer) completely deteriorate in strength and suffer enormously in colour owing to heavy formation of fungal spores. The effects are progressive with time and observation on strength tests made every fortnight gives their rates of development. At lower relative humidities, i.e. 90%, 75% and 60%, no deterioration in strength or whiteness has been observed in 4 months in B.D. 8, while in Broach Palej a slight tendency to increased infection and some loss in strength and whiteness has been noticed at 90% R.H. in the same period. Cottons kept at still lower relative humidities, i.e. 30% and dry, the latter over anhydrous granulated calcium chloride, did not show any loss in strength even in an year. These experiments are in progress.

80. A self-recording apparatus for determination of fibre-strength.

S. S. Sukthankar, N. Ahmad, *and* H. Nawkal, Bombay.

The paper gives an account of an apparatus designed by the authors for measuring the strength of textile fibres. A fibre is suspended from a hook fixed to a lever arrangement in which an electric circuit is completed as soon as it is straightened out. The other end of the fibre is attached to a float suspended in a solution of calcium chloride contained in a U-tube. The tension on the fibre is applied by raising a counterpoise suspended from a string in the second arm of the U-tube. As this counterpoise is gradually raised the level of the liquid surrounding the float falls and the pull on the fibre increases steadily until it breaks when the float which had hitherto been held by the fibre drops in the U-tube. The counterpoise is raised by winding the string on a pulley, which is driven by a gear arrangement from a small electric motor. The same gear records the tension applied to the fibre on two calibrated dials, in units and hundreds. The arrangement for applying and recording the tension is connected to the electric circuit referred to above and works only so long as the circuit is complete. As soon as the fibre breaks, the electric circuit is interrupted and both the pointer and the counterpoise come to rest.

The mean values obtained with this apparatus for 20 cottons are given along with those obtained by the Magazine Hair Tester. It is found that the agreement between the two sets of values is good. In addition to being accurate, this apparatus is quick in action, while its costs of construction and maintenance are quite low.

The lower and upper quartiles, the coefficients of variation and the values of skewness calculated for the data obtained with these two instruments are also compared.

81. Natural weathering of paints and some considerations entering the technique of testing their durability.

Lal C. Verman, N. Ghatak *and* H. Trivedi, Calcutta.

Paint films, in service, are subjected to a large number of deteriorating influences of which the following more important ones are considered:—

(*a*) *Radiation of the sun*; visible, ultra-violet and infra-red.
(*b*) *Atmospheric air*; oxygen, ozone, ammonia, sulphur and nitrogen oxides, etc.
(*c*) *Water*; rain, dew and humidity of the air.
(*d*) *Micro-organism*; fungus and others carried by the atmospheric air.

The number of variables involved, their more or less random variations from year to year, coupled with the fact that the paint film may be exposed in any one of the innumerable dispositions conceivable, render the problem of determining the durability of paints an intricate one. The best that can be done under the circumstances is to expose the paint panels prepared under standard conditions in a standard disposition. The question of the type and shape of panel and the particular choice of disposition should, however, be carefully considered.

Existing methods are discussed and their drawbacks pointed out. Two methods have been adopted by the authors; in one it is intended to accentuate the effect of weathering influences as far as possible, while in the other an attempt is made to work under as normal conditions as practicable. The considerations entering into the two methods are discussed and it is intended to compare results obtained by them with those obtained under actual service conditions.

82. Accelerated weathering of paints and the development of a weatherometer suitable for tropical climates.

LAL C. VERMAN, H. TRIVEDI *and* N. GHATAK, Calcutta.

On account of the variability of natural weather and the fact that deterioration is rather slow, it is desirable to be able to compare within a reasonable length of time the performance value of paints under controlled weathering conditions. For this purpose a number of weatherometers have been developed, but the particular features necessary to reproduce tropical conditions necessitate a special type of instrument. Adaptation of a standard instrument with this point of view in mind is described and some of the results obtained with it are discussed.

83. Use of Indian bentonite in building materials.

A. D. BANERJI, C. A. KHAN *and* LAL C. VERMAN, Calcutta.

The usefulness of bentonite obtained from Rajputana has been investigated in building materials, particularly in conjunction with cement. It has been found that about 8–10% addition of bentonite to cement imparts to the latter fire-resisting properties, renders it waterproof, prevents segregation of aggregates and reduces setting time. Whether all these advantages can be fully exploited, depends on how the strength is effected. It has been found that compressive strength is reduced about 10% while the tensile strength suffers to a greater extent. But the latter is not a serious disadvantage, since it is seldom that cement concrete is expected to carry appreciable tensile loads.

84. Automatic cell-testing device.

G. D. JOGLEKAR *and* LAL C. VERMAN, Calcutta.

The automatic cell-testing device facilitates the intermittent testing of a bank of dry cells each of which has to be discharged individually through a fixed resistance. The device is worked by a wall-clock, which at a fixed time momentarily closes a circuit for a sensitive relay, the operating contacts of which are then closed, and remain closed until reset.

These contacts when closed switch on a circuit for a power relay, which in turn energises a solenoid, the plunger of which is then pulled down. The plunger when pulled tilts a bank of mercury switches, which in the tilted position close the individual electric circuits for the cells. Each of the cells is thus discharged through its own fixed resistance. After a fixed period of discharge, the clock again momentarily closes another set of contacts which operate a solenoid in the sensitive relay, which resets the relay contacts. This in turn de-energises the main solenoid thus bringing the mercury switches back to their normal open position. The cells are now left to recuperate until the clock contacts again come into operation.

At present the cells are being discharged twice a day for half an hour at an interval of 12 hours. By fixing the contact points on the clock at suitable positions any desired length of time of discharge and of recuperation may be obtained.

85. Thermal endurance of electric lamp glass bulbs.

S. Mujtaba Karim, Lal C. Verman *and* S. V. Anantakrishnan, Calcutta.

As the electric lamp bulbs in normal use are subject to sudden fluctuations of temperature, resistance to thermal shock is a very important characteristic that any glass used in the manufacture of bulbs should possess.

A method for determining the thermal endurance of electric lamp bulbs based on the maintenance of uniform temperature gradient through the wall thickness is described and lamp bulbs of different makes have been arranged in order of their thermal endurance. Further results obtained for the determination of a relation between the wall thickness and the thermal endurance indicate that the thermal endurance increases with the decrease of the wall thickness as may be expected from earlier works on the subject. No definite correlation between the wall thickness and thermal endurance has, however, emerged because of the difficulty of obtaining a series of bulbs of widely varying wall thickness.

86. The maximum efficiency of tungsten filament electric lamps.

D. R. Bhawalkar, Calcutta.

From energy considerations, the luminous efficiency of a tungsten filament electric lamp is very low—of the order of 5% only. Most of the energy in the total radiation appears in the infra-red region and part of the remaining energy is lost by conduction and convection. The design of electric lamps is discussed from this point of view, taking into account the recent improvements. For electric lamps in common use it does not seem possible that the luminous efficiency will be greatly increased by further improvements, as certain losses are inevitable. The conversion of the ultra-violet radiation into visible radiation by using fluorescent paints is also discussed and shown to be of little value in increasing the efficiency of tungsten filament electric lamps.

87. The use of vegetable oils as fuels for internal combustion engines.

H. D. Chowdhury, S. N. Mukerji, A. N. Kapoor *and* J. S. Aggarwal, Lahore.

Vegetable oils have been tried as fuels in compression ignition (Diesel) engines by some workers notably in France, Belgium, and China as substitutes for mineral fuel oils. But, except in France, no systematic work appears to have been done on the subject. The present paper deals with (i) the examination of the physical and chemical characteristics of eight Indian vegetable oils (viz., groundnut, karanj, punnal, polang, castor, kapok, mahua and cotton seed); (ii) the results of preliminary trials runs undertaken on them in a 8 B.H.P. Lister Diesel engine running at 1200 r.p.m. with a view to studying their startability, output and running conditions, etc., and (iii) the results of a prolonged run of 50 hours' duration in the same engine under standardized conditions with three of the above oils (viz. groundnut, polang and karanj) and an account of the nature of deposits on various engine parts and of corrosion noticed.

It has been found that some of these oils behave in the engine almost as satisfactorily as the high speed diesel mineral oil as regards startability, power output, smoothness of operation and overall thermal efficiency, although pitting of the exhaust valve seat and the cylinder head was noticed after prolonged runs with some oils having a high acid value. Further work on other Indian vegetable oils is in progress.

88. Some experiments on the thermal repulsion of particles.

L. A. Ramdas *and* S. Y. Joglekar, Poona.

Dust particles in the air space between two parallel plates, under conditions when convection is absent and the thermal gradient is uniform, are repelled at a uniform velocity from the hot to the cold plate. Some experiments are described in which the movement of a particle under the combined influence of gravity and the thermal gradient can be examined. From the velocity measurements, the particle size and the thermal force can be estimated directly. The work is in continuation of the earlier work done by Mr. M. K. Paranjpe in this laboratory.

89. A magnetic investigation of the photohalides of silver.

Parmanand Sharma *and* L. N. Srivastava, Lucknow.

The three silver halides—silver chloride, silver bromide, and silver iodide all darken in light, the degree of darkening decreasing roughly in the order given.

The nature of the dark product has, however, long been the subject-matter of considerable researches. None of the methods so far employed has given any satisfactory result.

The magnetic susceptibilities of the pure silver halides in evacuated sealed tubes have been determined before and after exposure to sunlight using a Bhatnagar-Mathur balance but without the optical arrangement. The investigation has yielded very interesting results, a discussion of which is presented in the paper.

90. Thermal properties of films of liquid Helium II.

M. Zakiuddin, Aligarh.

Different workers on liquid helium II have suggested from time to time that this liquid has the property of forming thin films on surface of the containing dewar. No direct proof of its existence has been given. I attempted to detect the presence of such films, to calculate its thermal conductivity and its thickness.

At one end of a capillary of german silver there was a heater and at the other two phosphor bronze thermometers. Readings were taken after calibrating the phosphor bronze thermometers without and with helium gas at 200 atmospheres in the capillary. The difference in the temperature gradient and the knowledge of the heat supplied gave an idea about the presence of this film. Later the thermal conductivity and thickness of liquid film was also calculated.

It is gratifying to note that the thickness of the film obtained by the author (of the order of 10^{-5} cm.) has been recently confirmed by Russian physicists.

91. Transfer of liquid helium II.

M. Zakiuddin, Aligarh.

Kammerlingh Onnes at Leiden observed that liquid helium II has got strange properties of moving from one vessel to the other. Attempts were made with different glass bulbs to study its transfer below 2·19° K. It was found that liquid helium II moves from one vessel to another contradictory to all existing laws of Physics.

92. On the specific heat of lac.

G. N. Bhattacharya, Ranchi.

The specific heat of lac and lac constituents has been determined by ordinary calorimetric methods using paraffin oil as the calorimetric liquid within the ranges of temperature between 25°C. and 45°C. and between 0°C. and 25°C. It has been found that kusum lac (both shellac and seed lac) has the highest specific heat among the different varieties of lac and that the specific heat of soft lac resin is higher than that of hard lac resin. Moreover, it has been noticed that the polymerized lac has for its specific heat a lower value than that of ordinary shellac or seed lac, the heat hardened lac having the lowest value. It has been thought probable, therefore, that the lower value of specific heat in the case of heat hardened lac is due to elimination of water from the molecule during condensation. This view gains further support from the fact that the specific heat of chemically hardened lac, which is considered as a simple polymerised product without elimination of water, is not so low as that of heat hardened lac. It has also been concluded that within the temperature range of 25°C. and 45°C., lac is in the state of softening, though not ordinarily perceptible, which fact is evident from the vast difference in the values of specific heat determined within the two above mentioned ranges.

93. The law of ellipticity for the minor axis in a Foucault's pendulum.

B. Dasannacharya *and* B. S. Gautam, Benares.

It was shown by B. Dasannacharya (*Phil. Mag.*, *25*, 601, 1938) that the ratio of the minor to the major axis developed by a Foucault's pendulum in a given time is different in different directions of initial vibration and that it is given by

$$\gamma=\gamma_0 \sin 2(\phi-\phi')$$

where ϕ is the initial direction of vibration and ϕ' and γ_0 are constants depending on a particular fixing of the pendulum, γ the rigidity of the thread used for suspension, γ_0 is a measure of the irregular performance of the pendulum. The present investigation has shown the applicability of the above law when metallic wires such as of copper, steel, etc. are used instead of the strings of silk and cotton used by Dasannacharya. The performance of a pendulum of only 30 cm. in length will be discussed in the light of the above findings.

94. Optical silvering on glass by the chemical method and the critical rôle of the extent of surface.

B. Dasannacharya *and* A. C. Seth, Benares.

Although recipés for silvering are many and conditions prescribed critical, it is found that it is difficult to get flawless mirrors which could be used for optical purposes required in physical instruments. The paper refers to the determination of the effect of temperature, concentration of solutions, and cleanliness of the glass surface to be silvered and above all to the fact that an optimum value of area of surface exists for which the best mirroring is obtained irrespective of the concentration of the silver nitrate used. This area is 500 sq. cm. per gramme of silver nitrate.

SECTION OF CHEMISTRY

President:—P. B. Sarkar, Dr.es Sc., A.I.C., F.N.I.

Inorganic Chemistry

1. Complex compounds of biguanide with tervalent metals, cobalt phenyl-biguanidine and its salts.

P. R. Rây *and* H. Bhattacharya, Calcutta.

Like the simple biguanidine its phenyl derivative has also been found to form characteristic inner metallic complexes with tervalent cobalt. The anhydrous and hydrated cobalt phenyl-biguanidines and a large number of its salts have been prepared, their properties studied and the constitution of the complex ion discussed.

2. Compounds of biguanide with bivalent metals, copper biguanidine and its salts.

P. R. Rây *and* P. N. Bagchi, Calcutta.

The unstable iodide, thiocyanate, hypophosphite, thiosulphate, nitrite and sulphite of cupric copper have been found to be quite stabilized by the formation of inner metallic complexes with biguanide molecules. Preparation of the hydrated and anhydrous cupric biguanidine and a number of its salts has been described. A study of their properties supports the constitution already suggested for the complex compounds of biguanide with bivalent metals.

3. Chromium chromates.

V. T. Athavale *and* S. K. K. Jatkar, Bangalore.

Continuing our previous work on reactions of chromates at high temperatures, we have confirmed the existence of a stage at 25% in the decomposition of the mixtures of chromates with the corresponding oxides of calcium, strontium and barium, due to the formation of the compound $10\text{-}11\text{-}12RO\ 6CrO_3\ Cr_2O_3$. The vapour pressures and the heats of decomposition of these compounds are being studied.

The remarkable stability of the basic chromates of alkaline earth is illustrated by the fact that the same chromium chromate $4CrO_3\ Cr_2O_3$ yields two compounds $8RO \cdot 4CrO_3\ Cr_2O_3$ and $9RO\ 4CrO_3\ Cr_2O_3$, the latter being far more stable to heat than the former.

A study of the vapour pressures and the chemical reactions of the products formed at 66% and 75% stages in the decomposition of pure chromates shows that these are mixtures of chromic oxide, chromite and the compounds formed at 33% and 40% decomposition of the mixtures of chromates with the corresponding oxides.

4. Experiments on resolution of co-ordinated inorganic compounds. Part III. Co-ordinated copper compounds with propylene diamine.

P. Neogi *and* K. L. Mandal, Calcutta.

Copper can form 6-co-ordinated complex salts and we attempted to prepare such compounds with propropylene diamine which could be resolved into optical isomers. The compounds prepared by us, however, were found to be 4-co-ordinated compounds and therefore could not be resolved. Bispropylenediamine cupric chloride, bromide, iodide, sulphate, nitrate, tartrate, camphor sulphonate, hydroxide, nitronate, acetate have been prepared. The compounds possess beautiful violet or blue violet colour and are quite stable and also soluble in water. The specific rotations of the tartrate, camphor-sulphonate and nitronate have been measured.

5. Resonance reactions. Part II.

P. Neogi *and* K. L. Mandal, Calcutta.

Neogi, Neogi and Chatterjee (J.I.C.S., 1928, *5*, 279) showed that maleic acid was partly converted into fumaric acid when SO_2 was passed through a solution of the acid in which MnO_2 was suspended though neither SO_2 nor MnO_2 or the products of the reaction alone could bring about the conversion. This was repeated by Neogi and Mittra (J.I.C.S., 1929, *6*, 969) who confirmed the result and named such a reaction 'resonance reaction'. Owing to the importance of the result, the reaction was further studied (1) to establish the formation of fumaric acid by preparing its methyl ester, and (2) to ascertain the conditions under which the best yield of fumaric acid is obtained by varying the proportions of MnO_2 and maleic acid. As regards the first point, the preparation of methyl fumarate and its identification by taking the mixed melting point of a mixture with a known sample of methyl fumarate has placed the formation of fumaric acid beyond doubt. As regards the second point, it has been shown here that the best yield of fumaric acid, namely 50%, is obtained when the proportions of maleic acid and MnO_2 are about 4 : 1. With a view to find other instances of 'resonance reaction', the combined action of MnO_2 and SO_2 has been tried on optical isomers to see if any change in optical rotation took place which would show the transformation of *d*- to *l*-isomers or vice versa. Taking *d*- and *l*-tartaric acids no such changes have been observed.

6. On the potassium salt of a new borohydrate.

R. C. Ray *and* P. C. Sinha, Patna.

It has been shown by one of us (*Trans. Faraday Soc.*, 1937, *33*, 1260) that two isomeric borohydrates of the composition, $H_6B_2O_2$, are formed in solution by the action of water on magnesium boride. Potassium salts of these isomeric borohydrates have been isolated, their properties studied, and their constitutions discussed. The reaction between the original boride and water comes to an end with extreme slowness, and repeated treatment with water is necessary to obtain appreciable quantities of the borohydrates.

When the 'spent' boride, obtained by the prolonged treatment of the crude boride with water, is treated with successive quantities of concentrated ammonia solution in an atmosphere of hydrogen, an ammonium salt of a borohydrate containing 4-atoms of boron in the molecule is formed. The ammonium salt is rather unstable, but it can readily be converted into the potassium salt which may be isolated. The properties of the 'four-boron' borohydrate have been studied and its structure discussed.

7. Reaction of sodium thiosulphate and organic acids in the solid state.

L. N. Srivastava, Lucknow.

A mixture of solid organic acid and solid sodium thiosulphate reacts immediately liberating sulphur dioxide. This is accompanied by a secondary reaction which liberates hydrogen sulphide. The sulphur dioxide from the primary reaction destroys the hydrogen-sulphide and the latter is not detected ordinarily. But if salts of other metals are present in the mixture, the corresponding sulphides are formed and these are detected in the course of analysis.

(Perfectly dry mixture does not, of course, react; but the introduction of a little moisture even by loosely corking the tube brings about the reaction.)

8. Electrolysis of aqueous magnesium chloride solutions.

S. S. JOSHI *and* VICTOR CALDWELL, Benares.

Results are given for the electrolysis of moderately concentrated solutions of magnesium chloride under a variety of conditions, *viz.*, the electrode materials, bath concentration and temperature, use of diaphragms and addition agents. Magnesium oxychloride, capable of yielding free chlorine, is the principal product. Its formation is maximum with a platinum anode and a mercury cathode of *large* area. There is also obtained a solid material of low solubility consisting chiefly of magnesium hydroxide, magnesium peroxide and magnesium hypochlorite; magnesium chlorate is produced only in traces. The addition of ammonium chloride or hydrogen peroxide has a marked influence in increasing the yield of the peroxide.

9. Behaviour of nitrogen peroxide under electric discharge. Anomalous pressure reversal effect.

S. S. JOSHI *and* K. S. VISVANATHAN, Benares.

Pure nitrogen peroxide was subjected to ionization by collision in the annular space of a Siemen's *type* ozoniser due to alternating electrical fields of 100 cycles frequency and at a P.D. of about 5,000 volts (r.m.s.). The reaction was followed by analyzing the decomposition mixtures at various intervals and also by observations of pressure change at constant volume by means of a special '*spoon type*' glass manometer. The system contained nitrogen, oxygen and undecomposed nitrogen peroxide as the principal constituents at all stages during the reaction. Data are given for the initial velocity of the decomposition of nitrogen peroxide as a function of the gas pressure and intensity of the applied field. It was also observed that the initiation of the decomposition under discharge was characterized by a minimum potential across the ozoniser.

It was observed at certain stages that the pressure of the reaction mixtures under the discharge showed a periodic variation. The corresponding electrical quantities such as the ionization currents through the reaction space and wattage input to the primary of the transformer indicated a similar and synchronous behaviour.

10. Decomposition of phosphine under electrical discharge.

S. S. JOSHI *and* T. D. BHASKAR, Benares.

In continuation of earlier work (Joshi and Krishnan, *Proc. Ind. Sci. Con., Chem. Sec.*, 1938, p. 48) 'threshold potentials' for the decomposition of phosphine have been determined as a function (i) gas pressure, (ii) frequency, and (iii) temperature. At this potential the ionization current also increased markedly. The course of the decomposition was followed by noting pressure change at constant volume, and at constant applied voltage; the first stage of the decomposition corresponded to $2PH_3 \rightarrow P_2 + 3H_2$. A further continuation of exposure to discharge produced a progressive and marked reduction of pressure.

presumably due to the formation of adsorption complexes between hydrogen and the lower hydrides of phosphorous. Stages corresponding to the formation of these were conveniently followed by measuring the ionization current. The current increased rapidly during the first stage of the decomposition as represented by the above equation. It showed a like diminution during subsequent stages characterized by diminution of pressure. It is considered that the hydrogen adsorption is marked during the conversion into red phosphorous of the yellow, which is first produced under the discharge. The deposits consisted of a series of multi-coloured rings on the high tension electrode. It was observed that the presence of a lower phosphide like P_2H_4 had an appreciable influence in decreasing the rate of phosphine decomposition.

11. Electrolytic formation of calcium chlorate from aqueous calcium chloride by electrolysis.

S. S. JOSHI *and* GOPAL TRIPATHI, Benares.

Arising out of work started in these Laboratories some considerable time ago on the possible utilization of calcium chloride, which is almost a waste product in a number of industries, was the question of a study of the conditions of the electrolytic formation of calcium chlorate. Working with 10 to 30 per cent. solutions of calcium chloride, yields of the chlorate using the following electrodes were examined: gas carbon, graphite, copper, mercury, aluminium, iron and platinum, other factors being kept constant. The following current densities were tried: 2, 4, 6, 10, 12, 16, 20 and 8 amp. per sq. dcm. The last quantity worked out the best. With this value for the current density and platinum electrode, the influence of temperature was studied in the range 20 to 90°C.; 80°C. was the optimum temperature. Under these two conditions and after ascertaining the optimum inter-electrode distance (*viz.* cms.), data were obtained for the current efficiency in the presence of cerium chloride, ferric chloride, potassium permanganate, suspensions of manganese dioxide. titanium oxide and lime, sodium nitrate, sodium sulphate, hydrogen peroxide, hydrochloric acid, air bubbled under pressure, sodium dichromate, caustic soda and sodium tungstate. Very satisfactory results were obtained with the following materials: sodium dichromate>permanganate>alkali>sodium tungstate.

12. Electrolytic formation of sodium chlorate from brine mixtures.

S. S. JOSHI *and* K. SRINIVASAN, Benares.

An examination has been made of the influence of almost all the experimental parameters of the above process with a view to elucidate the conditions leading to a maximum current efficiency in regard to the formation of the chlorate, by varying the disposition of the electrodes, the temperature, concentration and especially the acidity of the bath material, the nature of the electrodes and their separation, and current density at either of the electrodes. Significant results have been obtained as to the influence of sun light on the progress of reaction and of the presence in varying amounts of a number of '*addition agents*'. The following were found to *increase* appreciably the final yield: potassium chromate, potassium permanganate, sodium tungstate and uranium oxide.

13. Synthesis of potassium permanganate from Indian raw materials.

S. S. JOSHI *and* L. S. CHANDRAKANT, Benares.

Investigations were carried out into the possibility of synthesizing $KMnO_4$ on semi-large scale from Indian materials. The existing methods employ chiefly KOH, MnO_2, $KClO_3$, of which KOH and MnO_2 are almost entirely imported. In view of the abundant deposits of KNO_3 in Bengal, Bihar, and the Punjab, and especially of MnO_2, numerous experiments were conducted to examine, in the first instance, the possibility of replacing KOH by KNO_3. The results were almost entirely negative even in the presence of varying amounts (in small proportions) of $KClO_3$ and some catalysts. Very satisfactory yields of permanganate were obtained in a series of trials in which $KClO_3$ was replaced by KNO_3; in fact under certain well defined conditions, amounts of KNO_3, very appreciably smaller than the costlier imported $KClO_3$ have given good and equivalent yields of the final product.

A detailed series of experiments was next carried out on the producibility of $KMnO_4$ by electrolytic means. The well known method of electrolysis of aqueous alkali between ferromanganese electrodes was altered in some detail so as to be adaptable to Indian conditions. Further work shows that optimum conditions in regard to the yield of permanganate prevailed in the electrolysis of a fused mixture of the above-named components. It is interesting that the possibilities of this process have not been hitherto investigated in the field of permanganate synthesis. The paper reports data in regard to the influence of (i) temperature, (ii) fused mixture, (iii) the applied P.D. and current density at either of electrodes, (iv) duration of electrolysis, (v) nature of the material and position of the electrodes, (vi) presence of *addition agents* or catalysts, (vii) results on the super-imposition of A.C. on the D.C. producing the electrolysis, and (viii) composition of the final melt near either of the electrodes.

The principal product of the electrolysis is potassium-manganate, which is converted into the permanganate by oxidation after the electrolyzed mass is lixiviated with acidified water. Great difficulties were experienced due to the presence of KNO_2 produced during the electrolysis. This exerts a powerful reducing action on the final yield of permanganate. This has been obtained by an appropriate adjustment of (ii), (iv), and (vi) and by increasing the cathodic surface which is first covered by a layer of manganese-dioxide. This is believed to be the mainly important region in which K_2MnO_4 is produced for which a mechanism is suggested in terms of the significant ionic and molecular species. Results are also reported on the electrolysis of KNO_3 and KNO_2 in the fused condition which are interesting, the reaction having been but scarcely reported in the literature.

14. Studies in active nitrogen. Part II.

S. S. JOSHI *and* A. PURUSHOTHAM, Benares.

In part I (Joshi and Purushotham, *Proc. Ind. Sci. Con., Chem. Sec.*, 1938, p. 48) of this series it was observed that under certain conditions a marked spectral shift came about in the 'after glow' of active nitrogen on aerial exposure to emissions from a heavy condensed discharge the latter being optically screened from the seat of the after glow. Subsequent work revealed the interesting possibility of inducing this spectral shift almost in entirety by exposure of active nitrogen to electric discharge. The following experiments were therefore carried out to obtain, in some quantitative detail, more information about this phenomenon. Active nitrogen was obtained with condensed series spark discharge in a Rayleigh tube actuated by an induction coil. This active nitrogen was allowed to flow and was isolated in a pre-evacuated Paschen tube of a special design. Critical potentials requisite for the spectral shift by use of 'controlled' electrons were determined as functions of the following parameters: (i) electron affinity of the medium, (ii) frequency of the A.C. supply, and (iii) temperature. Very considerable difficulties were caused due to electromagnetic induction from the primary condensed discharge in the transformer circuit which was induced by a coherer effect (the characteristic susceptibility for which on the part of active nitrogen was observed for the first time in these Laboratories) a measure of the above spectral shift. This was eliminated by a specially designed multi-switch mechanism which ensured the exposure exclusively of the isolated active nitrogen to the field operating the controlled electrons. Variations under (i) were secured by introducing in *low* proportions the following gases at various partial pressures: air, nitrogen, oxygen, hydrogen, water vapour, ammonia, nitrogen peroxide, nitric oxide, hydrogen-sulphide, hydrochloric acid, nitrous oxide, carbon dioxide, sulphur dioxide, and carbon disulphide. Under (ii) the frequency was varied from 50 to 500 cycles per second. Except in the case of the last four amongst the above-mentioned gases, it was observed that the accelerating potential diminished in the presence of any of the added gases, the actual magnitude being roughly proportional to the relevant partial pressure. The results have been interpreted, following Franck and others, in terms of collision of the second type, between the foreign molecules and those of active nitrogen, the kinetic energy of the accelerated electron being considered to be the chief determinant. It was noticed that the electronic isomers exercised a like influence on the critical potential producing the spectral shift.

15. Studies in active nitrogen. Part III.

S. S. Joshi *and* A. Purushotham, Benares.

A review of the already large and rapidly growing literature on active nitrogen shows a marked deficiency of data necessary for the correlation of the electrical factors with the corresponding yield. The inclusion of a spark gap (sometimes more than one), condenser and especially the use of perhaps the most ill-defined source of electrical supply, *viz.*, the induction coil, detract markedly from visualizing the rôle of the significant electrical quantities. It was thought therefore to simplify as much as possible the components constituting the secondary circuit, which subsequently gave interesting results. It was found, for example, that the results are simpler to interpret and better controlled, by replacing the induction coil with a suitable transformer. Furthermore, it was noted that the rôle of the capacity and the spark gap in the production of active nitrogen has been stressed unduly in the literature on active nitrogen. We have succeeded in getting active nitrogen with a simple H.T. circuit and a *low* capacity discharge tube. The yield of active nitrogen increased by increasing both the pressure and the applied potential. The rôle of the frequency is not yet clearly understood. Working in the range of pressures from 2 mm. to 170 mm. (Hg) it was observed that the active nitrogen at a given pressure set in at a fairly sharp threshold potential. This quantity increased almost linearly with the gas pressure for a constant frequency of A.C. supply. Further work revealed the producibility of active nitrogen in ordinary Siemen tubes, both the duration and intensity of the after glow being satisfactory when considered in the light of the input energy and the corresponding secondary current. This mode of activation was also characterized by critical threshold potentials. Data were obtained for the influence on the threshold potential of the disposition of the electrical field and the length of the electrodes. A hysteresis effect was observed in the fact that almost always the deactivating or the extinction potential for active nitrogen was slightly but sensibly less than that distinctive of its formation.

16. Studies in active nitrogen. Part IV.

A. Purushotham, Benares.

In order to elucidate the mechanism of the influence of foreign gases (cf. Part II) on the critical potentials characteristic of the spectral shift in active nitrogen by electronic collisions, detailed studies have been made of the spectra of nitrogen in the presence of each of the following gases: hydrogen, water vapour, carbon monoxide and dioxide mixture and mercury vapour. The emission spectrum under different conditions of active nitrogen isolated as described previously (*loc. cit.*) has been recorded. These data have been examined microphotographically in respect of intensity variations. Spectrograms were taken after the occurrence of the 'spectral shift' in active nitrogen due to interaction with controlled electrons. The ensuing gas was almost completely free from any chemical reactivity when the spectral shift was due to electromagnetic induction from the primary discharge. In respect of the wavelength positions, the spectra of active nitrogen after subjection to electronic collisions and of ordinary nitrogen (*e.g.* in low voltage Geissler tubes) were sensibly identical.

17. Studies in active nitrogen. Part V. Wall effect.

A. PURUSHOTHAM, Benares.

The following experiments were carried out in order to examine the various factors on which the intensity of the 'after glow' in active nitrogen depended, *viz.*: (i) the nature of the walls of the containing vessel, (ii) its size, especially the ratio of the wall area to its volume, (iii) the gas pressure, (iv) the mechanism of activation, (v) mode of observation of the 'after glow', and (vi) presence of traces of foreign materials.

Nitrogen was activated by a condensed discharge in a Rayleigh tube and isolated in an observation chamber by use of a four-way stopcock, whereby the observation chamber could be connected or disconnected from the primary discharge tube and the exhaust *simultaneously*. The arrangement was found to be very convenient for measuring the duration of the 'after glow' under given conditions. Curves correlating gas pressure and the time of 'after glow' have been obtained. A number of experiments were made under (i) in which the inner surface of the observation chamber was coated with each of the following materials: thin films of silver, metaphosphoric acid, sulphuric acid, cleaning with chromic acid, arsenic oxide and thorium chloride. Interestingly enough, silver films had the maximum effect in prolonging the 'after glow', the influence of the other materials being represented by the above order. Experiments were carried out in which a layer of phosphorus pentoxide was first smeared on the inside of the observation vessel. The time of 'after glow' increased appreciably up to a maximum as the oxide was exposed to the atmosphere for increasing intervals. Evidence was also obtained which showed definitely that the 'after glow' became longer if the containing walls were pre-treated repeatedly with active nitrogen than if the gas entered a freshly cleaned vessel. It was also observed that the end point of the 'after glow' was markedly accentuated by using a detector material, such as traces of yellow phosphorous and especially iodine.

Experiments have also been carried out on the action of active nitrogen in hydrogen chlorine mixture, phosphine, metallic sodium at different temperatures, aluminium and silver.

Physical Chemistry

18. Magnetism and molecular constitution of some chromium compounds.

S. S. BHATNAGAR, BRAHM PRAKASH, *and* ABDUL HAMID, Lahore.

In the present work an attempt is made to define the structure of some chromium compounds from the magnetic standpoint. The susceptibilities of chromium ions in different valency states were calculated on the Van Vleck, Sommerfeld, Bose-Stoner formula:—

$$\chi_M = \frac{N\beta^2}{3kt}[4s(s+1)]$$

and compared with the experimental values determined on a modified form of Gouy's balance. Chromium dioxide is shown to contain quadrivalent chromium, the constitution of a complex chromium sulphate has been confirmed, silver chromate and the pyridine salt of the so-called blue perchromic acid, since shown by Schwarz and Giese to be a derivative of CrO_5 and not $HCrO_5$, have been shown to contain hexavalent chromium. The supposed hexavalency of chromium in chromium tetramino-tetraoxide and its pentavalency in pyridinium-tetrachloro-hydroxy-chromate $C_5H_5N \cdot CrCl_4 \cdot OH, H_2O$ and the analogous quinolinium salt have been controverted and alternative constitutions which are more satisfactory have been suggested. The three isomerides of chromic dichloro-aquotriammino chloride have been examined from the magnetic standpoint.

19. Diamagnetic susceptibility of chlorohydrate.

M. Qureshi *and* M. A. Hai, Hyderabad (Deccan).

Diamagnetic susceptibilities of solutions of chloralhydrate in benzene have been determined over a wide range of concentration, employing Gouy's method. The susceptibility-concentration graph is a straight line, which cuts the susceptibility-axis at a point corresponding to the gramme susceptibility of pure benzene, the maximum deviation from linearity being not more than 0·5%. The value obtained for the gramme susceptibility of chloralhydrate by extrapolation is $-0{\cdot}518 \times 10^{-6}$, which corresponds to a value of $-85{\cdot}73 \times 10^{-6}$ for the molecular susceptibility of chloralhydrate. The value obtained for the gramme susceptibility of chloralhydrate in the solid state is $-0{\cdot}52 \times 10^{-6}$, which is in close agreement with that obtained for the dissolved substance. The observed value, when compared to the value calculated from atomic susceptibilities, leads to the evaluation of a constitutive correction constant for aliphatic compounds, containing three chlorine atoms attached to the same carbon atom. The constitution of chloralhydrate has been discussed.

20. Magnetic susceptibilities of solutions of sodium and potassium nitrate.

S. P. Ranganatham *and* M. Qureshi, Hyderabad (Deccan).

Diamagnetic susceptibilities of solutions of sodium and potassium nitrate have been determined over a wide range of concentrations, employing a modified form of Quincke method with a photographic recording arrangement. The susceptibility-concentration graph is, in each case, a straight line, cutting the susceptibility-axis at a point corresponding to the susceptibility of pure water, the maximum departure from linearity being not more than 1%. The gram-ionic susceptibility of NO_3, calculated from these measurements using the theoretically calculated values for Na^+ and K^+, is different in the case of each salt, being less for the potassium salt. In view of the fact that there is a lack of agreement between the values for Na^+ and K^+, arrived at by different workers and the theoretical values calculated by different methods, no definite conclusion can be drawn with regard to the specific influence of the positive ion. It is, however, clear that the experimental values are, on the whole, much less than the theoretical value for NO_3, which is an indication of ionic deformation.

21. Magneto-chemical investigation of the photohalides of silver.

L. N. SRIVASTAVA *and* PARMANAND SHARMA, Lucknow.

Pure dry silver halides AgCl, AgBr, AgI, are prepared and exposed to sunlight. The unchanged halides were removed from the reduced products with suitable solvents. The course of reduction was investigated by measuring the magnetic susceptibility at each stage.

In order to get larger reduction of the halides, they were dissolved in concentrated ammonium hydroxide solution which was slowly allowed to evaporate in sunlight. The precipitate formed was washed free of ammonia, and the unchanged halides removed as before.

In the first case the presence of a paramagnetic substance was noticed, and in the second case that of a very strongly paramagnetic substance was definitely established.

22. Electrochemistry of resin solutions.

S. R. PALIT, Ranchi.

The electrolytic conductivity of alcoholic solutions of different resins including rosin, sandarac, pontianc, shellac, etc. have been measured and compared. It has been found that they are very weak electrolytes, their sp. conductivity lying within the range 10^{-5} to 10^{-6} reciprocal ohms. No parallelism between the specific conductivity and acid value of the resins could be established. It has also been observed that an alcoholic solution of a mixture of hard resin and soft resin in the proportion in which they are present in shellac has not the same conductance as the original shellac; it is therefore concluded that in shellac the soft resin and hard resin are perhaps present in a loose chemical combination.

For preparing pure electrolyte-free hard resin, a method of purification by emulsification in water and fractional centrifuging was adopted and was found to give satisfactory results.

23. Temperature coefficient of conductivity of an aq. solution of iodic acid.

M. R. NAYAR, Lucknow.

Solutions of iodic acid of concentration ranging from 0·01 N to 1·0 N are carefully prepared, and their conductivity determined at temperatures 20°C. and 30°C. While the equivalent conductivity plotted against concentration gives a smooth curve, the difference between the equivalent conductivities at 30° and 20°C. when plotted against concentration gives kinks at 0·04 N and 0·08 N. The results are discussed in the light of the previous work on viscosity, refractive index, parachor and other properties.

24. The temperature coefficients of electrical conductivity and viscosity of aqueous mercuric chloride at different temperatures.

S. S. JOSHI *and* D. N. SOLANKI, Benares.

A study of the electrical conductivity and viscosity of aqueous mercuric chloride was made at different concentrations, ranging from 0·125M to 0·00939M, and at different temperatures, 15°C., 20°C., 25°C., 30°C., 35°C., and 40°C. Our conductivity data show that $HgCl_2$ in aqueous solutions behaves almost like a non-electrolyte, even for fairly concentrated solution. Results show that the molecular conductivity Λ rises appreciably with rise in temperature, which is presumably due to a corresponding diminution in viscosity of the solvent and increase of the ionic mobilities. An additional factor has been observed in a small but measurable hydrolysis of $HgCl_2$, which increases with dilution and temperature.

No detailed information is available in the literature regarding the values for Λ_∞ the molecular conductivity for $HgCl_2$, at infinite dilution at different temperatures. An attempt was, therefore, made to evaluate these quantities by the method of Kraus and Bray (*J. Amer. Chem. Soc.*, 1913, *35*, 1315–1431). The validity of Kraus and Bray's expression,

$$\frac{1}{\Lambda}=\frac{1}{\Lambda_\infty}+\frac{1}{K.\Lambda_\infty^2}.(C\Lambda),$$

in the case of $HgCl_2$ was tested graphically by plotting $\frac{1}{\Lambda}$ against $(C\Lambda)$. The curves, *though straight lines*, did not give the intercepts in the required direction. Possibly, $HgCl_2$ may not undergo binary dissociation or its dissociation may be complicated due to such disturbing factors, as (*a*) the dissociation proceeding in stages, the existence of the intermediate ions, like HgCl, being shown by Morse from transport number measurements, (*b*) hydration or solvation,. (*c*) hydrolysis, giving rise to the additional ions, $H^\cdot$ and Cl'.

Our results on the temperature coefficients of conductance for $HgCl_2$ shew that the above quantity is variable in the range 3·8 to 6·2 per cent. and that it varies but only to a slight extent with the concentration and that it diminishes as the temperature rises. The abnormally high value for the temperature coefficient of conductance for $HgCl_2$ may be attributed to its non-electrolytic behaviour as the effect of temperature is more marked in the case of weak electrolytes rather than in the case of strong electrolytes. The absence of any alteration in temp. coefficient of conductance with concentration is indicative of non-existence of the hydrates in aqueous $HgCl_2$ due to the absence of the charged ions, which are mainly responsible for the hydration to take place. Our data showing the effect of temperature on the conductivity satisfy Kohlrausch's relation

$$\Lambda_t=\Lambda_{t_0}[1+\alpha(t-t_0)+\beta(t-t_0)^2]$$

the values of α and β being graphically evaluated. The fall in the temperature coefficient of conductance with rise in temperature can be explained on the view that with rise in temperature the association of water becomes less which brings about a lowering in the ionizing power of the solvent, thereby affecting the dissociation of the electrolyte.

Our results on the viscosity of aqueous $HgCl_2$ show that the viscosity coefficient increases with the concentration especially in fairly strong solutions, though in very dilute solutions difficulties arise owing to the fact that the viscosity of the solution differs from that of the pure solvent to a very small extent. Our data show that the variation of viscosity with concentration and temperature can be adequately expressed by the relations,

$$\log\eta=KC,\quad \log\eta=\frac{B}{T}-A,$$

where C is the volume concentration in moles per litre, T the absolute temperature, K, B, and A being constants. The temperature coefficient of viscosity increases with rise in temperature. It is interesting to note that the above quantity for the solvent (water) remains unaltered despite the varying concentration of $HgCl_2$ present in the system. Our data showing the effect of temperature on the viscosity of aqueous $HgCl_2$ satisfy the relation,

$$\eta_t=\eta_{t_0}[1+\alpha(t-t_0)+\beta(t-t_0)^2],$$

in accord with Bousfield and Lowry (*Proc. Roy. Soc.*, 1902, *71*, 338–350) the values of α and β being graphically evaluated.

25. Formation of complex ions in aqueous silver nitrate in the presence of sucrose.

S. S. JOSHI *and* SANKARANAND MUKHERJI, Benares.

Results have been obtained for the refractive index, conductivity, viscosity, density and the transport numbers in silver nitrate solutions in the presence of sucrose whose concentration was varied in the range 0 to 15 per cent. The last quantity diminished to a minimum in the neighbourhood of 10 per cent. and then increased. Determinations of the other properties did not show any discontinuity in the above region except in the case of viscosity at about 3 per cent. There was no evidence for hydration of either of the ions. Following considerations detailed elsewhere (Joshi and Padmanabhan, *J. Indian Chem. Soc.*, 1938, *15*, 176–190; Joshi and Solanki, *ibid.*, *15*, 167–175) above minima are attributed to complex formations in the system.

26. Studies in the hydrolysis of esters. Part I.

S. V. ANANTAKRISHNAN *and* T. N. KRISHNAMURTHI, Annamalainagar.

The mechanism of the hydrolysis of esters in acidic and alkaline media is usually considered to be comparatively simple giving rise to unimolecular or bimolecular velocity coefficients under the conditions of the experiments. An examination of the reaction in dilute solutions, however, indicates that this is not so. The existence of an induction period and the course followed by the reaction is more consistent with a chain mechanism. A tentative scheme is briefly outlined.

27. Theory of electro-deposition of chromium.

S. HUSAIN, Hyderabad (Deccan).

It is well known that satisfactory deposits of chromium are obtained only from hexavalent chromium baths and never from tervalent baths, in spite of the fact that metallic chromium is produced in the hexavalent baths, from the tervalent chromium, formed at an intermediate stage during the electrolysis.

It was, however, found that if the concentration of the tervalent chromium ion is suppressed by the addition of a large excess of a salt having a common anion, chromium can also be deposited from its tervalent salt. Thus a satisfactory deposit is obtained from a bath containing 20 c.c. of 0·0002M. chromic sulphate solution, 80 c.c. of saturated potassium sulphate solution and 17·5 c.c. of N sulphuric acid at a c.d. of 0·16 amp./cm.^{2}, sulphuric acid or potassium hydrogen sulphate being added to produce the necessary concentration of hydrogen ion.

This proves that any bath containing a large reserve of chromium, but a small concentration of tervalent chromium ion will yield a satisfactory deposit of chromium. Hexavalent chromium baths fulfil this condition and are excellent for chromium deposition.

28. Molybdenum electrode.

C. T. ABICHANDANI *and* S. K. K. JATKAR, Bangalore.

The behaviour of a molybdenum wire electrode has been studied over a pH range 2 to 10 in an atmosphere of hydrogen. The electrode shows a theoretical slope from pH 3 to 5 and from pH 9 to 10 indicating the existence of two oxides in the metal. The e.m.f.-pH relationship up to 10 pH is given by the expression $E = a + b\ p\mathrm{H}$.

29. Dissociation constants of hydroxy-benzoic acids and gallic acid.

C. T. ABICHANDANI *and* S. K. K. JATKAR, Bangalore.

The potentiometric titrations of ortho-, meta- and parahydroxybenzoic acids and gallic acid by 0·1 N sodium hydroxide have been carried out and first and second dissociation constants of these acids calculated. The treatment embodies the application of Debye-Hückel theory of interionic attraction and Gugenheim-Hückel expression for the variation of the ionic activity coefficients with concentration.

30. Dissociation constants of catechol, resorcinol, hydroquinone, pyrogallol and phloroglucinol.

C. T. ABICHANDANI *and* S. K. K. JATKAR, Bangalore.

The first and second $\left(K_1^a, K_2^a\right)$ dissociation constants of catechol, resorcinol, hydroquinone, pyrogallol and phloroglucinol have been calculated from the potentiometric titration at 30°C.; corrections for ionic activity have been applied. The results indicate that the introduction of a hydroxyl group in phenol tends to increase the first dissociation constant $\left(K_1^a\right)$ in the order para, meta, and ortho. The values of K_1^a for pyrogallol and phloroglucinol are considerably higher than the rest of the phenols.

31. Dissociation constants of tannic acids.

S. K. K. JATKAR *and* S. R. SUNTHANKAR, Bangalore.

The dissociation constants (K_A) of the various tannic acids prepared from myrobalan have been measured by the method of potentiometric titration. The following results were obtained: Gallic acid, K_1, $3{\cdot}8\times 10^{\;5}$; K_2, $2{\cdot}7\times 10^{-9}$; Ellagic acid, $2{\cdot}2\times 10^{-8}$; Ellagitannic acid, $1{\cdot}6\times 10^{-5}$ and Chebulinic acid, $3{\cdot}16\times 10^{\;6}$. The values of the dissociation constants have been discussed in relation to tanning, mordanting and plasticizing of clays.

32. Effect of inorganic colloids on the electro-deposition of nickel on iron.

V. S. PURI *and* F. R. M. ALVI, Lahore.

In general it is noticed that the electro-deposition of nickel on iron is rather difficult and the deposit is not very coherent unless special precautions are taken. Further quite a number of pits appear on the plates. The effect of the addition of colloids like silver chloride, silver bromide, silver, gold (red, blue and green), prussian blue and sulphur to the bath was studied. Silver, gold (red, blue and green) and prussian blue gave coherent deposits free from pittings, while the silver halides and sulphur had a negative effect. Several microphotographs were also taken.

33. The behaviour of organic solids on the surface of water.

G. V. L. NARASIMHA MURTI, Waltair.

A large number of organic compounds belonging to different groups are studied in regard to their behaviour on the surface of water. The influence of the various groups such as $-CO_2H$, $>C=O$, $-NH_2$, etc. in a substance on its behaviour on the water surface are discussed.

The percentage lowering of surface tension of the aqueous solutions of a number of typical compounds are recorded and the results compared with their behaviour on the water surface.

Combination movements exhibited by the pairs phenyl acetic acid-camphor, and *p*-nitrotoluene-*o*-nitrophenol are described.

34. The nature of the potential barrier at surfaces of solutions of capillary-active electrolytes.

K. S. Gururaja Doss, Mysore.

It is known that the accumulation of solute molecules at surfaces of solutions of capillary-active electrolytes is a very slow process. The low rate of accumulation has been interpreted by the present author as due to a potential barrier present at the interface. The potential barrier has now been identified with the diffuse electric double layer developed at interface by the first lot of the capillary-active ions accumulated at the surface. Considerations based on the potential of the double layer are helpful in interpreting the peculiar form of the time-area curve. It has also been possible, without introducing any arbitrary assumption, to interpret the influence, on the rate of accumulation, of factors such as the concentration of the solute, electrolytes and *p*H. The effect of electrolytes on the collapse pressure of films is also explained. The electrical double layer at the interface also provides an explanation of the denudation of the solution just below the surface layer (cf. McBain). Furthermore, the new effect observed by Schuto and Adam, in their work on the equilibrium surface tension of solutions of cetyltrimethyl-ammonium chloride gets a plausible interpretation.

35. Adsorption and retention of helium by cocoanut shell charcoal.

P. R. Subbaraman *and* K. R. Krishnaswami, Bangalore.

During the course of our studies on adsorption of helium by cocoanut shell charcoal at liquid air temperature, we have also noticed (1) that all the adsorbed gas cannot be recovered by pumping to a Töpler vacuum, (2) the quantity of helium retained by the charcoal varies directly with the pressure during adsorption.

The measurements involved the introduction of accurately measured quantities of very carefully purified helium into the charcoal bulb cooled in liquid air and noting the pressure of gas at the end of the adsorption. The gas in the apparatus was then fully pumped out (the charcoal bulb being surrounded by liquid air throughout) by the Töpler pump attached to the apparatus, collected and measured again. The difference in the volume of the gas gave the quantity retained by the charcoal.

The experimental details and the significance of the results obtained are described in the paper.

36. The relative activities of samples of adsorbent charcoal as determined by different methods.

M. V. C. Sastri *and* K. R. Krishnaswami, Bangalore.

The relative adsorptive powers of four samples of active charcoal, viz., norit, blood-charcoal, philburgin and animal charcoal were determined by the following methods: (1) adsorption of benzene in the vapour phase from a mixture of benzene and air, (2) adsorption of iodine from a decinormal aqueous solution, (3) adsorption of methylene blue from aqueous solution.

In the first case the procedure involved the determination of the increase in weight of the specimen after adsorption, whereas in the second and third cases, titrations with $Na_2S_2O_3$ and colorimetric estimations using a Rober instrument respectively were resorted to. *p*H determinations were also made during the progress of the methylene blue adsorption. The relative activities of the specimens examined are summarized below:

Specimen.	Activities as determined by method.		
	No. 1.	No. 2.	No. 3.
Norit	8·1	10·0	2·9
Blood char.	10·2	15·2	7·6
Dhilburgin	3·1	1·2	1·2
Animal char	1·0	1·0	1·0

The significance of results obtained by the various methods are discussed from the theoretical points of view.

37. Influence of electric fields on the viscosity of colloids.

S. S. Joshi *and* V. C. Subbaiah, Benares.

In confirmation of earlier results (S. S. Joshi and G. N. Khade, *Proc. Indian Science Congress, Chem. Section,* 1938, p. 47) using a specially designed modification of the Scarpa apparatus, it has been observed that the *diminution* of viscosity at a constant temperature of a colloid under an alternating electrical field disposed transversely to the direction of transpiration is a widely occurrent phenomenon. The arrangement employed allowed of a determination of a change in viscosity of 1 in 7500. Careful measurements of the diminution of viscosity under the field have been recorded in the case of *til* oil emulsion and colloidal solutions of gold, copper oxide, As_2S_3, Sb_2S_3, CdS, HgS, MnO_2, V_2O_5, Al_2O_3, molybdenum blue, prussian blue and sodium oleate, the percentage diminution of viscosity varied in the range 0·07 to 4·79, the sulphides showing the largest effect. Failure to reproduce the pre-field viscosity after the removal of the field, indicated that a measure of a permanent change was produced during the time of exposure. In all the above systems observations were also made of viscosity from time to time during long periods of continuous transpiration under the field. It was found that the viscosity in general diminished to a *minimum*. This was followed by a rise to a maximum where it either remained stationary or, diminished and repeated the cycle.

In some though not all the cases the rather significant observation was made that insipient coagulation was induced after long exposures to the electric field. This has been interpreted in the light of a general result obtained in these laboratories (Joshi and Viswanath, *J. Indian Chem. Soc.*, 1933, *10*, 329; Joshi and Menon, *ibid.*, 1933, *10*, 599; Joshi and Nanjappa, *ibid.*, 1934, *11*, 133; Joshi and Iyenger, *ibid.*, 1934, *11*, 555, 573; Joshi and Panikkar, *ibid.*, 1934, *11*, 797; also *J. Chim. Phys.*, 1935, *32*, 455; *Proc. Acad. Sci.*, U.P., 1935, *5*, 41) that diminution to a minimum is almost always the first stage in a *slow* coagulation of a colloid produced either electrolytically or by '*mutual*' coagulation. The above results are discussed in terms of micellar (i) *deformation* induced under the applied field, and (ii) *orientation* in the '*viscous*' or linear flow at a given rate of shear.

In agreement with earlier findings (*loc. cit.*) the above electroviscous effect was found to be but insensible for pure liquids and aqueous solutions of electrolytes under alternating electric fields. For continuous or stationary potentials the effect was negligible even in colloids.

38. Studies in bivalent metallic soaps.

S. S. BHATNAGAR, P. L. KAPUR, *and* A. HUSSAIN, Lahore.

Different samples of zinc and magnesium oleates were prepared by varying the amounts of the electrolyte and the mono-valent soap. As a result of the analysis of the samples thus prepared, it is observed that the metal and the acid are not present in stochiometric ratios with the exception of zinc oleate obtained by refluxing zinc dust and oleic acid. This sample of zinc oleate melts at 85·5° while the other samples melt at a much lower temperature. Similar behaviour is observed in case of magnesium oleate. It has been suggested that these variations are due to the adsorption of various ions by the metal soap formed.

Study of physical properties such as solubility, molecular weight, surface tension, viscosity, conductivity and molecular magnetic rotation using benzene as solvent reveals that the behaviour of magnesium oleate is different from that of zinc oleate inasmuch as it shows conductivity, abnormal high molecular weight in the solid state, comparative higher viscosity and variation of molecular magnetic rotation with concentration. This difference in behaviour has been ascribed to the greater tendency of adsorbing various ions by magnesium oleate than by the corresponding zinc soap.

39. Studies in gels of sodium oleate.

MATA PRASAD *and* K. N. MATHUR, Bombay.

Clear transparent sodium oleate gels have been prepared for the first time in pinene and the setting of the same has been studied at different temperatures using solutions of different sodium oleate content. The time of setting decreases with increase of sodium oleate, and increases with rise in temperature. The sol $\rightleftharpoons$ gel transition has been followed thermally and has been found to take place perfectly smoothly in a manner which shows that the heat content is smaller in the gel state than in the sol state, as has been found to be the case with other gels by previous workers.

Refractive index, magnetic susceptibility and the syneresis of these gels with varying sodium oleate contents and at different temperatures have also been studied with a view to determine the structure and the mechanism of formation of these gels.

40. Studies in coagulation and gelation by viscosity and opacity measurements.

MATA PRASAD *and* K. V. MODAK, Bombay.

Coagulation of zirconium hydroxide sol, gelation of stannic phosphate gels and the coagulation and gelation of concentrate stannic hydroxide sol have been studied with a view to corelate the phenomenon of coagulation and gelation. The progressive coagulation and gelation with time have been followed by viscosity and opacity measurements; for the latter a photo-cell was used.

Viscosity-time curves for the coagulation of zirconium hydroxide sol by large amounts of KCl are smooth but with smaller amounts, they are discontinuous or zonal. The addition of alcohol and rise of temperature hasten coagulation. The opacity-time curves are 'S' shaped. In the gelation of stannic phosphate the initial change of viscosity is very small for a long period and is followed by a sudden rise. The viscosity-time curves are smooth. The opacity-time curves are more or less 'S' shaped. The effect of temperature on these gels is to hasten the gelation while addition of KCl and alcohols delays the setting of the gels.

The viscosity-time curves during the coagulation of stannic hydroxide sol by KCl and $BaCl_2$ are smooth. Mercuric chloride produces discontinuous or zonal curves in both coagulation and gelation, when sufficiently slow. The discontinuities are more marked when the readings are taken at very short intervals during the gelation of the sol which gives highly thixotropic gels. Opacity curves are regular and 'S' shaped. Alcohol accelerates the coagulation and gelation while glycerine retards them.

41. The yield value of thixotropic bentonite suspensions.

N. C. Sen Gupta, Calcutta.

Consistency curves of thixotropic sodium bentonite suspensions at three different concentrations, for which the times of solidification in a test tube were 4′, 55′ and >24 hrs. have been obtained with a modified Couette viscometer.

Following characteristics have been observed:—

(*a*) the systems do not possess any true yield value;

(*b*) the curves show the general characteristics of structure viscous substances investigated by Ostwald and others and fairly constant coefficients of viscosity, η_0 and η_∞, are obtained at very low and very high rates of shear respectively. This is in agreement with the theories of Reiner and Philippoff;

(*c*) η-η_∞ decreases exponentially with the increase in the rate of shear.

42. A comparison of the properties of 'humic acid' obtained from different sources.

G. C. Esh *and* S. S. Guha Sircar, Dacca.

A study has been made of the percentages of C, H, N, ash, methoxyl, acetyl and furfural-yielding complexes of humic and hymatomelanic acid fractions of three 'humic acids' one obtained from Messrs. Schuchardt of Germany and two others obtained from an Assam soil of high organic-matter content. Points of similarity and points of difference are indicated. Results of further acetylation, methylation and H_2O_2-oxidation are also compared. Some potentiometric and conductometric titrations of soil humic acid are described, and also the results of Freudenberg degradation (methylation followed by KOH fusion) which gave products similar to those obtained by one of the authors from lignin.

43. The interaction of silicic acid sol with concentrated alkalis.

B. Chatterjee, Calcutta.

The potentiometric titration curves of silicic acid sol with concentrated solutions of caustic soda show second inflection points (in addition to those observed in the acid region on titrating the sol with dilute bases) at high *p*H values. The lower the silica content of the sol, the lower is the *p*H at which inflection in the curve occurs. A fair agreement between the total acidity expressed in normality (per litre) calculated from the inflection point and the silica content (analytical) of the sol (expressed in gram mol. per litre) has been observed. The effect of time in the interaction of silicic acid sol with concentrated caustic soda has been studied.

44. Diffusion analysis of sodium silicate solutions.

R. C. Ray *and* P. B. Ganguly, Patna.

The constitution of sodium silicate solutions containing different ratios of silica has been investigated by Harman (*Jour. Phys. Chem.*, 1925, *29*, 1155; 1926, *30*, 917; 1926, *30*, 1111) who indicated that most of the silica is present probably as complex ions. In a previous paper one of us (*Jour. Phys. Chem.*, 1927, *31*, 407) has shown, from diffusion measurements across membranes, that a considerable portion of the silica is present as colloidal aggregates. Since then a large amount of work has been done on silicic acids and the silicates by different workers and the existence of mono- di- and other silicic acids have been definitely established.

In the present investigations concentrated silicate solutions of varying silica content formed the bottom layer of a long wide tube, and were allowed to diffuse freely into a supernatant layer of water. After several days, solutions were drawn out from different layers and the amounts of silica and sodium as well as hydrogen ion concentrations were determined. The results seem to give clear indication of the presence of colloidal aggregates when the ratio of $SiO_2 : Na_2O$ is above a certain value. The analytical results have been used to explain the composition of aqueous sodium silicate solutions and conclusions have been drawn as to the *p*H under which complex silicate ions can exist in solution.

45. Dehydration of fuller's earth.

B. S. KULKARNI *and* S. K. K. JATKAR, Bangalore.

The dehydration of activated Indian Fuller's earths from different sources has been studied over a wide range of temperatures. The dehydration curves of high grade earths show common characteristics and resemble those of montmorillonites but differ distinctly from those of the kaolinitic materials on the one hand and those of purely surface-active compounds like kieselguhr, on the other. The activity of the earths for base exchange and for decolorization of oil is maximum for dehydration between 150°–200°C., gradually decreases with higher temperatures and is destroyed at 800°C., showing that removal of adsorbed water increases activity, while the loss of water of constitution acts adversely. The latter is closely related to the loss of hydrogen zeolite in the material, the exchangeability of which was studied by *p*H measurements. A comparison between the ion exchangeability of earth samples dehydrated at various temperatures and their decolorizing efficiency has confirmed our previous conclusions about their close interdependence.

46. Photo-reduction of ferric chloride in the presence of acetaldehyde.

MATA PRASAD *and* C. R. TALPADE, Bombay.

The photo-reduction of aqueous ferric chloride in the presence of aqueous acetaldehyde solutions has been studied with different concentrations of ferric chloride and acetaldehyde at different temperatures in presence of light of different wavelengths of different intensities. The reaction is monomolecular and while the velocity constant decreases with an increase in the concentration of ferric chloride, it increases with an increase in the concentration of aldehyde. The velocity constant also increases with (1) an increase in temperature, and (2) decrease in the wavelength of the incident light.

This reaction has also been studied in sunlight wherein it tends to be zeromolecular even though there is a gradual decrease in the value of x/t with progress of time.

The quantum efficiency of the reaction increases with (1) decrease in the wavelength of incident light, (2) increase in temperature, (3) increase in the concentration of aldehyde, and (4) decrease in the concentration of ferric chloride.

47. Action of light on some organic colouring matters.

C. M. Desai *and* B. K. Vaidya, Bombay.

The photochemical decomposition of the following colouring matters has been investigated in aqueous solutions and in crystalline state under different experimental conditions: crystal violet, malachite green, brilliant green, picric acid, naphthol yellow, chrysoidine and (aminoazobenzene). The photoprocess has been followed: (i) under the influence of different actinic sources—quartz mercury vapour lamp, glass enclosed carbon arc and sunlight, and in the presence of (ii) hydrogen peroxide, and (iii) some copper and nickel salts.

The absorption spectra of the exposed solutions in the ultraviolet region of the spectrum indicate that the glass enclosed carbon arc closely reproduces the effect of sunlight, but with the mercury vapour lamp the change is not necessarily the same as that brought about by sunlight.

The thermal and photochemical oxidation of dyes by hydrogen peroxide as also the effect of copper and nickel salts on the photochemical change have been studied and the mechanisms of these reactions are discussed.

The products of photodecomposition in sunlight have been in some cases identified and isolated.

48. Phototropy and photochemical isomerism from the magnetic standpoint.

S. S. Bhatnagar, P. L. Kapur, *and* M. S. Hashmi, Lahore.

A magnetic study of such phototropic and photoisomeric compounds as anils, hydrazones, anthracene, *o*-nitrobenzaldehyde, thiophosgene has been conducted. It has been observed that in anils and hydrazones, where the change in colour is ascribed to change in aggregation of the molecules, no effect on their magnetic susceptibility is observed on exposure to light, but in thiophosgene, *o*-nitrobenzaldehyde where there is a change in constitution on exposure the magnetic susceptibility of the exposed sample is different.

49. The rates of reaction of *p*-alkyl benzhydryl chlorides with ethyl alcohol.

N. A. Taher, Hyderabad (Deccan).

The velocities of the unimolecular alcoholyses of benzhydryl chloride and its *p*-substituted alkyl derivatives have been measured at 25°C. All the alkyl substituents examined increase the rate of reaction and the order of activities is $Me > Et > Pr^{\beta} > Bu^{\gamma}$. This is an agreement with Baker and Nathan's postulate regarding the order of electron-release capacity of these groups. The observed velocity coefficients are

$k \times 10^5$ (sec.$^{-1}$) = H, 5·30; *p*-Me, 124; *p*-Et, 120; *p*-Pr^{β}, 106; *p*-Bu^{γ}, 98·7.

50. Studies in the heterogeneous reaction between chromium oxide and potassium permanganate.

Mata Prasad *and* K. N. Rao, Bombay.

The above named reaction has been studied (1) with particles of chromium oxide of different sizes, (2) with solutions of potassium permanganate of different concentrations, and (3) at different temperatures. It has been found that the reaction is very rapid in the beginning but slows down in the end. No constant values are obtained from the relation for the unimolecular reactions. However straight lines have been obtained on plotting the unimolecular constant against the reaction velocity calculated as $\frac{x}{t}$.

51. Activity of different catalysts for vapour phase esterification.

S. K. K. Jatkar *and* R. K. Valvekar, Bangalore.

Esterification in the vapour phase has been studied from thermodynamical standpoint as well as by experimental method. Although the percentage of esterification in the vapour phase at equilibrium is high, the reaction velocity in presence of silica gel catalyst is very low. For this reason, it is not possible to employ the vapour phase esterification for commercial work. We have, therefore, studied the comparative activity of different catalysts for vapour phase esterification of acetic acid by ethyl alcohol at 150°, where the thermodynamical equilibrium is favourable for complete conversion. We have found potassium hydro-sulphate and activated carbon as the best catalysts. In the case of both of these catalysts, the maximum conversion observed is only 94% and 89% of the equilibrium conversion at high space velocities, owing to the temporary poisoning of the catalyst mass by water vapour. It has been concluded that silica gel is the most unsuitable and unreliable catalyst for esterification in vapour phase at 150°.

52. Equilibrium between methyl alcohol, acetic acid, methyl acetate and water.

S. K. K. Jatkar *and* N. G. Gajendragad, Bangalore.

Although there are numerous papers on esterification equilibria in vapour phase of ethyl alcohol and acetic acid, there has been no attempt so far to find out the corresponding equilibrium constant in the reaction of methyl alcohol and acetic acid. It is well known that the equilibrium constant for the reaction of ethyl alcohol with acetic acid in vapour phase is very much higher than the values in liquid phase. We have shown that this holds good even for the vapour phase esterification of acetic acid by methyl alcohol.

53. Esterification equilibria in vapour phase.

T. Subramanya *and* S. K. K. Jatkar, Bangalore.

The esterification equilibria in vapour phase at 240° have been studied by using active carbon as the catalyst. The equilibrium conversion is 75% in the case of esterification of equimolecular mixture of acetic acid with propyl, butyl and amyl alcohols as against 67% in the liquid phase. With alum as catalyst there is simultaneous establishment of ether and ester equilibria.

54. Studies in binary mixtures.

S. K. K. Jatkar *and* (Miss) Nagamani Shama Rao, Bangalore.

A systematic study of the properties of binary systems has been started with a view to find out the effect of complex formation on the physical properties in liquid mixtures. Measurements of dielectric constants, refractive index and densities of mixtures of isoamyl alcohol with carbon tetrachloride have revealed the existence of the complex $2CCl_4$, Iso-AmOH. In the case of the system methyl alcohol and water, there is evidence to show the compound formation MeOH, $2H_2O$ from measurement of density, viscosity and refractive index.

55. Adsorption from binary mixtures.

S. K. K. Jatkar *and* (Miss) Nagamani Shama Rao, Bangalore.

The adsorption from binary mixtures of methyl alcohol and water, benzene and isoamyl alcohol, carbon tetrachloride and isoamyl alcohol, and toluene and acetic acid has been studied by using activated charcoal. In the case of all the mixtures the adsorption isotherms show that the selective adsorption is either zero or maximum when the composition of the mixtures correspond to the compounds CH_3OH, $2H_2O$; Iso-AmOH, $4C_6H_6$; Iso-AmOH, $2CCl_4$; $C_6H_5CH_3(CH_3COOH)_2$; $C_6H_5CH_3$ $2(CH_3COOH)_2$; $C_6H_5CH_3$ $3(CH_3COOH)_2$. We have thus a new method of proving the existence of molecular compounds in liquid systems.

56. Equilibrium in electrodeless discharge.

R. Krishnan *and* S. K. K. Jatkar, Bangalore.

The remarkable divergence in the values of equilibrium conversions observed in the Siemen's ozoniser by the static and dynamic methods, has been shown to be due to the fact that appreciable quantities of atomic oxygen are present in the ozoniser in equilibrium with molecular oxygen and ozone. In dynamic experiments we get higher values for percentage conversion owing to freezing of the reaction products. The values of the equilibrium constants for various initial pressures of oxygen have been experimentally found under static conditions at different exciting voltages in a pyrex ozonizer, for the two equilibria which are simultaneously established, viz.: (1) $O^*_2 \rightarrow 2O$ and (2) $O^*_2 + O \rightarrow O_3$. Under ordinary conditions of working the equilibrium is such that one atom of oxygen and one molecule of ozone are in equilibrium with twelve molecules of oxygen. Application of thermodynamics to the chemical equilibria observed in electrical discharge, has been attempted.

Carbon dioxide gave a mixture of ozone, oxygen and carbon dioxide, the yield of ozone being comparable with that when oxygen was passed in the apparatus.

57. Behaviour under high tension electric discharge of films of nitrous oxide at liquid air temperature.

S. S. Joshi *and* G. S. Deshmukh, Benares.

In pursuance of previous results on the electrical decomposition of N_2O (*Trans. Farad. Soc.*, 1927, *23*, 227–238; *ibid.*, 57; 1929, *25*, 108–117; 1929, *25*, 118–129; 137–143; 143–147) the above extension of the mode of experimentation was thought to be desirable on several considerations, especially from the standpoint of applying results of general kinetic theory of gases to velocity of decomposition under a given field strength due to alternating potentials. Furthermore, the evaluation of the potential drop which is a principal determinant of the corresponding electronic activation of the exposed material is relatively more precise, when a film is bombarded instead of a gas. A consideration of the energetics of the reactions becomes also simpler at liquid air temperatures as also the analysis of the decomposition mixture and especially the thermal effects usually attendant in high tension discharges. Ionization vessels of different types had to be tried before a proper selection could be made. It consisted principally of a triode like vessel with a layer of pure mercury distilled *in situ* at one end, kept at liquid air temperature and always earthed, and on which the gas was frozen by application of liquid air. The high tension terminal was in the form of a flat spiral parallel to the mercury surface. An additional electrode which was always earthed was introduced at the other end of the tube. It made for a smooth and continuous discharge. The discharge was produced by use of a stepped up A.C. and also by stationary potentials by means of a system of rectifiers. The velocity of decomposition was sensibly greater under the latter conditions.

The decomposition was studied as a function of a given field strength under different initial conditions, viz., (i) vacuum, (ii) low pressures of air, (iii) nitrogen, and (iv) hydrogen. Oxygen was given out in all the cases. This was conveniently fixed by mercury to give HgO even at liquid air temperatures and thus removed from the field so as to eliminate further interaction. Some undecomposed N_2O was also present at the end of any given exposure. The other components of the decomposition mixture were N_2 and NO in (i); N_2O and NO in (ii); only N_2 in (iii) and N_2, H_2 in (iv). Variation of the time of exposure in the range 1 second to 4 hours gave interesting results. For instance under (i), if the time of exposure exceeded 50 seconds, the products were invariably NO_2 and N_2. It is shown that the first stage of decomposition gives NO, which decomposes, $NO \rightarrow \frac{1}{2}N_2 + \frac{1}{2}O_2$; the last oxidizes NO to NO_2. Evidence for this deduction has been afforded by the fact that time —NO conc. curve yields a very pronounced maximum distinctive of an intermediate product. A mechanism is suggested for the decomposition of a nitrous oxide molecule under ionic impact in terms of the nature and the kinetic energy of the impacting ion. Results confirmatory of the above findings were obtained when the bombardment was due to *positive ions only* from various gases actuated by definite potential drops.

58. The hydrogen-chlorine reaction due to electronic activation.

S. S. Joshi *and* V. Narasimhan, Benares.

Taylor investigated the hydrogen-chlorine reaction under the influence of α-rays and demonstrated its close similarity with the change when produced photochemically, especially in regard to the efficiency of HCl formation reckoned per ion and per quantum. The present paper reports, results for the above reaction induced under discharge due to alternating electrical fields of commercial frequencies, in the annular space of a Siemens' ozoniser. The gas pressures were measured by a glass, 'spoon type' manometer used as a null instrument. The progress of the reaction under the discharge was followed by measuring (1) the ionization current across the reaction space, and (2) change in wattage input to the transformer primary. The current diminished rapidly almost immediately after the commencement of the discharge, during a period whose duration varied (increased) with the gas pressure at a constant applied potential. Using pure chlorine, and hydrogen obtained by electrolysis of aqueous hydrogen chloride, drying them over a train of phosphorus pentoxide tubes and in absence of an addition agent, the discharge reaction was free of any 'induction period'.

The reaction was studied in the pressure range 10 to 40 cm. Hg; the composition being varied so as to have large excesses of either of the components. The reaction at any given pressure of the mixture was characterized by a minimum, 'threshold potential' which had to be exceeded to initiate the change. This quantity may be related simply with the corresponding Paschen potential known for pure gases; no such information, however, is available as regards reactive mixtures. Measurements for hydrogen-chlorine mixtures have revealed the interesting result that, the 'threshold potential' is determined almost entirely by the partial pressure of chlorine presumably because of its high 'electron affinity'.

Determinations of this quantity are now in progress in these laboratories for a number of reactions produced under the discharge. It has been observed that the number of hydrogen chloride molecules formed per ion is very large (as in the photochemical and α-ray changes), the actual value being determined principally by the gas pressure and the electrical factors characteristic of the discharge. These two quantities are also the chief determinants of the velocity of the reaction under the discharge. Results are also obtained for (1) the photochemical superimposed by an electronically activated reaction, (2) influence of addition agents of known rôle in the photochemical change, (3) of frequency of the applied potential, and (4) dielectric strengths for chlorine at different pressures and frequencies.

59. Viscosity and density of aqueous solutions of sulphuric acid at 35°C.

M. K. SRINIVASAN *and* B. PRASAD, Cuttack.

Viscosity and density of aqueous solutions of sulphuric acid have been measured at 35° ± ·005. For dilute solutions it has been shown that Jones and Dole expression holds very satisfactorily up to a concentration of 0·0400M. The viscosity-concentration curve for the more concentrated range shows a maxima at about 86% and a minima at about 95% which if taken to indicate compound formation would point to hydrates of the composition H_2SO_4, H_2O and $3H_2SO_4$, H_2O. It is, however, not possible to prove by viscosity measurements whether they are present. While the formation of a maxima or a minima in case of a mixture of liquids may be explained by a consideration of the effect of mixing the liquids on molecular forces it is difficult to explain the presence of both save by assuming the presence of a compound at about 86% of the composition corresponding to H_2SO_4, H_2O.

The density of the very dilute solutions varies linearly with concentration up to 0·1146M. In the more concentrated region it goes on increasing with concentration up to about 99% after which it begins to decrease.

60. The effect of ageing on the viscosity of shellac-urea solutions in alcohol.

G. N. BHATTACHARYA *and* S. RANGANATHAN, Ranchi.

The viscosity of alcoholic solutions of shellac of varying concentrations with the addition of different percentages of urea as an accelerator has been measured and the effect of ageing has been studied. It has been found that for dilute solutions (up to about 10%) the effect of ageing is not so pronounced. In the case of more concentrated solutions (10 to 25%) the viscosity is the highest with about 3 to 4% of urea and 2 to 3 weeks ageing. It decreases slowly after attaining this maximum.

61. The space configuration of nitrogen in the 3-covalent state.

B. K. SINGH, Patna.

The tetrahedral arrangement of four groups covalently linked to nitrogen has been definitely settled by the investigations of Mills and Warren.

The arrangement of three groups attached to a 3-covalent nitrogen atom, as in an amine N *abc*, remained for long as one of the outstanding problems in stereochemistry. In this paper, stereochemical considerations, based on experimental evidence, are adduced to show that the nitrogen atom does not lie in one plane with the three attached groups.

This result is in harmony with physical evidence, based on electric moment, crystal structure, and infra-red absorption spectra.

62. An X-ray investigation of the crystals of *o*- and *p*-nitro-benzoic acids.

MATA PRASAD, M. R. KAPADIA, *and* V. C. THACKAR, Bombay.

The crystals of *o*- and *p*-nitro-benzoic acids belonging to the triclinic pinacoidal and monoclinic prismatic class respectively have been studied by the single crystal rotation method, using Cu *K* radiation. The rotation and oscillation photographs were taken about *a*, *b* and *c* axes and the dimensions of the unit cell are found to be:—

(1) *o*-nitro-benzoic acid: $a = 7{\cdot}58\text{A}^\circ$; $b = 14{\cdot}03\text{A}^\circ$; $c = 5{\cdot}05\text{A}^\circ$
$\alpha = 131^\circ{\cdot}11\tfrac{1}{2}'$; $\beta = 109^\circ{\cdot}37'$; $\gamma = 61^\circ{\cdot}54\tfrac{1}{2}'$
$a : b : c = 0{\cdot}5403 : 1 : 0{\cdot}3599.$

This agrees with that given in Groth (IV, 472). The unit cell contains 2 molecules and the space group is $C'i$.

(2) *p*-nitro-benzoic acid: $a = 12{\cdot}88\text{A}^\circ$; $b = 5{\cdot}05\text{A}^\circ$; $c = 21{\cdot}21\text{A}^\circ$
$\beta = 96^\circ{\cdot}38'$
$a : b : c = 2{\cdot}551 : 1 : 4{\cdot}160.$

This agrees with that given in Groth (IV, 478). The unit cell contains 8 molecules.

63. Periodic deposits under canal ray discharge.

S. S. JOSHI, V. T. CHIPLONKAR, *and* G. S. DESHMUKH, Benares.

Results are given for the formation of periodic structures on a number of metallic and non-metallic receptacles which were impacted with by high speed atoms, molecules and ions in the canal rays. A number of gases at *low* pressures charged with traces of such accessory material like vapours from waxes, iodine, pitch, etc. were employed. The anode potential, varied in the range 1,500 to 3,000 volts D.C., was obtained from an H.T. transformer and rectified by a Kenetron. This determined mainly the density, size and the periodicity of the deposit, for given values of the gas pressure, discharge current, inter-electrode distance, length and the disposition of the canal and especially the duration of the discharge. Results are given illustrating the effect of each of these parameters on the corresponding patterns of the deposit. With a symmetrically disposed canal, the patterns obtained showed a remarkable resemblance with the well known '*Liesegang ring*' phenomenon observed in colloids and other precipitates. While the electrical constants were responsible for the general configuration of the patterns, the carrier material served mainly to 'develop' and 'fix' them. These are remarkably stable to heat at moderate temperatures. It is considered that ordinary adsorption complexes with the above carrier material would give patterns far less stable than those now observed under the canal discharge.

64. Luminescence of phosphorus under electric discharge.

S. S. JOSHI *and* G. K. NAYAR, Benares.

Results are reported for the characteristic voltage- ionization current-curves at different pressures of oxygen mixed with inert and other gases, the pressure being varied in the range about 1 m.m. to 72 cm. Hg at different frequencies of the alternating current supply. Data are also obtained for the kinetics of the oxidation of the phosphorus under the above mentioned conditions. Results were markedly different from those observed by numerous workers on the so-called glow of phosphorus due to aerial oxidation in the presence of various contaminants. Reaction under the discharge progresses smoothly and uniformly once the minimum threshold potential was exceeded. It showed no evidence of the well known 'explosion pressure limits' typical of the thermal change for which an explanation has been worked out on the basis of ratio 'Wall area/Volume' of the reaction vessel and the time ratio of the evolution of the heat of oxidation of phosphorous. Data are also given for the spectral characteristics of the glow in the discharge under different conditions of gas pressure. The predominant effect of the discharge was the conversion of the pale yellow phosphorous film into red. The influence of gas pressure on the threshold potential was much less marked in this than any other reaction under discharge so far examined.

Organic Chemistry.

65. Condensation of methyl succinic anhydride with phenolic ethers.

P. C. MITTER *and* LAKSHMIKANTA DE, Calcutta.

Anisol condenses with methyl succinic anhydride in nitrobenzene in presence of anhydrous aluminium chloride, at the ordinary temperature to give α-methyl-β-anisoyl propionic acid M.P. 144°C. This on Clemmensen reduction gives α-methyl γ-(p-methoxy phenyl) butyric acid, B.P.S. 180–182°. On treatment with phosphorus pentoxide the substance undergoes ring-closing with the formation of 1-keto-2-methyl-7 methoxy 1 : 2 : 3 : 4-tetrahydro-naphthalene B.P.$_5$ 150–152°. Clemmensen reduction of the ring ketone yielded 2-methyl-7-methoxy-1 : 2 : 3 : 4 tetrahydronaphthalene B.P.$_5$ 114-115°, which on selenium dehydrogenation gave 2-methyl-7-methoxy naphthalene M.P. 89-90°.

Phenol condenses with methyl succinic anhydride under similar conditions giving α-methyl-γ-(o-hydroxy phenyl) γ-keto-butyric acid M.P. 161° which on reduction is converted to α-methyl-γ-(o-hydroxy phenyl) butyric acid B.P.$_{5.5}$ 170–173°.

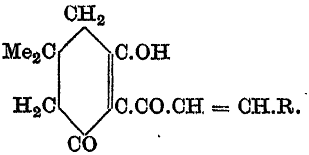
From resorcinol dimethyl ether, α-methyl β-2 : 4 dimethoxy-benzoyl propionic acid M.P. 131° and another product M.P. 141-142°, probably the second possible isomer, is obtained.

With pyrogallol trimethyl ether partial demethylation takes place and α-methyl β-(2-hydroxy 3 : 4 dimethoxy) benzoyl propionic acid M.P. 155° and another product probably the second possible isomer, is obtained. From the first, by methylation α-methyl γ-(2 : 3 : 4 trimethoxy-phenyl)-γ-ketobutyric acid, could be obtained. From the unmethylated acid, α-methyl-γ-(2-hydroxy-3 : 4 dimethoxy phenyl) butyric acid M.P. 83–85°, 1-keto-2-methyl 5-hydroxy-6 : 7-dimethoxy-1 : 2 : 3 : 4-tetrahydro naphthalene M.P. 130–132°, and 2-methyl 5-hydroxy-6 : 7-dimethoxy 1 : 2 : 3 : 4 tetrahydronaphthalene B.P.$_6$ 152–154° could be obtained by reduction ring closing and subsequent reduction in the usual manner.

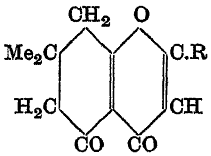
66. Condensation of C-acetyl-methone with aromatic aldehydes.

B. H. IYER, Bangalore.

C-acetyl-methone has been condensed with benzaldehyde, salicylaldehyde and anisaldehyde in presence of alcoholic potash and the resulting ortho-hydroxy-hydro-aromatic chalkones of type (I) isolated by saturating the reaction solution with carbon dioxide.



(I)



(II)

(R = Aromatic aldehyde.)

Experiments are in progress to convert these hydroxy-chalkones into derivatives of flavones of type (II) by the method of Taichiro Oyamada (*Bulletin of the Chem. Soc., Japan*, 1935, Vol. 10, No. 5, p. 182) using 15% hydrogen peroxide and 16% alkali. Condensations with *o*-nitrobenzaldehyde, vanillin and piperonal did not proceed in so facile a manner as in the above cases.

67. Condensation of methyl β-resorcylate with ethyl acetone dicarboxylate and ethyl α-chloroacetoacetate.

S. M. SETHNA *and* R. C. SHAH, Bombay.

In continuation of previous work, methyl β-resorcylate has been condensed with ethyl acetone dicarboxylate and ethyl α-chloroacetoacetate in presence of sulphuric acid and the products obtained have been proved to be 7-hydroxy coumarin derivatives. The same condensations are being carried out in presence of anhydrous aluminium chloride.

68. Condensation of protocatechuicaldehyde with malonic acid in the presence of organic bases. Synthesis of caffeic acid.

K. C. PANDYA *and* T. S. SODHI, Agra.

Protocatechuicaldehyde condenses with malonic acid in the presence of traces of pyridine, under the usual conditions, yielding caffeic acid. The highest yield obtained is about 44% of theory. Perkin's method gives first the diacetylcaffeic acid (Tiemann and Nagai, Ber. II, 656). A large variety of conditions of condensation were tried. The only method that gave a larger yield (54·5%) was to keep the aldehyde, malonic acid and a pyridine-piperidine mixture in a stoppered flask at room temperature (summer) for three months.

As protocatechuicaldehyde has two hydroxyl groups, the yield of the resulting acid could not be expected to be high: but it is higher than was the case with resorcylaldehyde, where one of the hydroxyl groups is ortho to the aldehyde group. It may be also noted that piperonal, in which the two hydroxyls have been replaced by a -O.CH_2O-group, gave almost theoretical yield.

69. Condensation of *o*-, *m*- and *p*-nitrobenzaldehydes with malonic acid in the presence of organic bases.

D. B. SINGH *and* K. C. PANDYA, Agra.

The nitrocinnamic acids are generally prepared by direct nitration of cinnamic acid or by condensation of the appropriate nitrobenzaldehyde with malonic acid in the pyridine-piperidine mixture.

The method of using only a trace of pyridine is also very effective and it gives yields from 80 to 90% of the corresponding nitro-cinnamic acid. The method is the same as has been employed in earlier condensations.

70. Application of H.C. value method in determination of unsaturation.

M. N. Goswami *and* Sibsankar Chatterjee, Calcutta.

It has been shown that the determination of unsaturation in oils can be very conveniently and correctly determined by absorption of hypochlorous acid (*J. Indian Chem. Soc.*, 905, *11*, 1934). The process consists of saponifying the oil and determination of amount of HOCl absorbed. In determination of unsaturation of soap the ordinary method consist of separation of fatty acids, drying, weighing and then determination of iodine value of the fraction. Apart from the time taken in such determination (about 3-4 hours) the process is open to serious objection as the solubility of lower fatty acids in water is neglected. In the case of H.C. value method it can directly be applied and no separation of fatty acid is needed. The process has been tested with variety of soaps and has been found to be very satisfactory. It takes one half an hour in determining the value.

71. Studies in the naphthalene series. Part III. The synthesis of 2-butyl and 4-butyl-α-naphthols and some mixed diacyl-α-naphthols.

R. D. Desai, Ashraf Ali, *and* H. P. Shroff,
Aligarh *and* Bombay.

Methods have been worked out for the best and improved yields of 2-butyryl and 4-butyryl-α-naphthols. Reduction with amalgamated zinc gave 2-butyl and 4-butyl-α-naphthols together with certain neutral products which were characterized as 2-butyl and 4-butyl-1 : 2 : 3 : 4-tetrahydro-α-naphthols. Mixed diacyl-α-naphthols were prepared by the action of acid chlorides in the presence of either anhydrous aluminium chloride or zinc chloride.

72. Studies in the naphthalene series. Part IV. Synthesis of trans-decahydro-naphthalene-2-carboxy-3-acetic acid.

Nazir Ahmad, R. D. Desai, *and* G. S. Sahariya,
Aligarh *and* Bombay.

This acid was synthesized from 2-cyano-$\Delta^{2:3}$-octahydronaphthalene the constitution of which was proved by its oxidation to trans-cyclohexane-1 : 2-diacetic acid. The acid exists in two forms; only one of which could be isolated in a state of purity. The characteristic derivatives of this acid have been prepared.

73. Studies in the Friedel-Crafts reaction. Part V. The action of acid chlorides and anhydrides on orcinol and resorcinol derivatives.

R. D. Desai *and* (Miss) V. M. Vakil, Bombay.

In part IV of this series (in the Press), one of the authors (R.D.D.) showed that orcinol reacted with acetyl chloride in the presence of anhydrous aluminium chloride giving rise to simultaneous β- and γ-substitution. Resacetophenone behaved similarly. We have extended this observation to benzoyl chloride and propioxyl chloride and also to resacetophenone and orcacetophenone with some interesting results.

74. Studies in cyclohexane series. Part IV. The synthesis of 4-methylcyclohexane 1 : 1-dicarboxylic acid and 3-methylcyclohexane-1 : 1-dicarboxylic acids.

R. D. Desai, R. F. Hunter, *and* G. S. Sahariya, Aligarh *and* Bombay.

4-methylcyclohexane-1 : 1-dicarboxylic acid has been found to exist in two forms. Similarly two isomeric forms of 3-methylcyclohexane-1 : 1-dicarboxylic acid have been prepared. These results show that these derivatives of cyclohexane possess the multiplanar configuration. This is the first authentic proof of the multiplanar forms of the cyclohexane ring.

75. Studies in the cyclohexane series. Part V. Synthesis of 2-methyl-, 3-methyl-, and 4-methylcyclohexane-1-carboxy-1-α-benzylacetic acids.

R. D. Desai, R. F. Hunter, *and* G. S. Sahariya, Aligarh *and* Bombay.

These acids were prepared in order to see if the isomers demanded by the multiplanar forms of cyclohexane could be isolated. However, only two isomers could be isolated in each series. The inability to isolate the four forms may be due to the extreme labile character of the other forms. Various derivatives of these acids have been prepared to characterize them.

76. Studies in 2-naphthyl chromones.

B. G. S. Acharya *and* T. S. Wheeler, Bombay.

2-Methoxy-napth-1-aldehyde has been condensed with *o*-hydroxy-acetophenone and 1-hydroxy-2-acetonaphthone to give the respective *chalkones*. These have been converted into the respective *dibromides*, viz., *o*-hydroxy phenyl *α-β-dibromo-β-2-methoxy naphthyl -1-ethyl ketone*, and 1-*hydroxynaphthyl α-β-dibromo-β-2-methoxy-naphthyl-*1-*ethyl ketone*. The β-bromine atoms in these compounds are found to be labile as with the dibromides of phenyl-*p*-alkoxy-styryl ketones, and form *β-alkoxy*-compounds with alcohols. The corresponding *benzoflavones* and *arylidene coumaranones* have been synthesized from these dibromides and corresponding alkoxy compounds.

77. 2-naphthylchromones.

V. V. Virkar *and* T. S. Wheeler, Bombay.

2-Naphthylchromones were prepared (A) from 2-alkoxydiaroylmethanes by the action of hydriodic acid or hydrogen bromide in acetic acid and (B) by dehydration of *o*-hydroxydiaroylmethanes, obtained by the molecular rearrangement of *o*-aroyloxyacetoarones; using metallic sodium.

By method (A) 6 : 7-benzoflavone (symmetrical naphthaflavone); 2′-methoxy 6 : 7-benzoflavone; 2-(2′-naphthyl)-6 : 7-benzochromone; 2-(1′-methoxy-2′-naphthyl)-7 : 8-benzochromone, and by method (B) 2-methyl-7 : 8-benzochromone; 2-(α′-naphthyl)-7 : 8-benzochromone; 2-(β′-naphthyl)-7 : 8-benzochromone; 2-(3′-methoxy-2′-naphthyl)-7 : 8-benzochromone have been obtained. On hydrolysing 6 : 7-benzoflavone or 2′-methoxy-6 : 7-benzoflavone with sodium ethoxide they give 2-hydroxy-3-acetonaphthone; this reaction provides a convenient synthesis for this compound.

78. Ring closure of $\alpha\gamma$-diarylbutyric acids.

M. SAMIULLA *and* T. S. WHEELER, Bombay.

β-Aroyl-α-arylpropionitriles have been obtained either directly from the corresponding chalkones with hydrogen cyanide or through the chalkone-dibromides by the action of potassium cyanide (Dodwadmath and Wheeler, *Proc. Ind. Acad. Sciences*, 445, 2, 1935). These on hydrolysis yield the corresponding keto-acids, which have been reduced to the $\alpha\gamma$-diarylbutyric acids (Richardson, Robinson and Seijo, *J.C.S.*, 838, 1937). Attempts are being made to close the ring to obtain the tetrahydronaphthalene derivatives, which are of importance in the syntheses of alkaloids of the Chelidonine-Sanguinarine group.

79. Studies in the chemistry of chalkones.

R. K. KAMAT *and* T. S. WHEELER, Bombay.

p-Benzyloxy-benzaldehyde has been condensed with acetophenone and dimethoxy-resacetophenone to give the corresponding chalkones. The dibromides of these chalkones have the same properties as those of *p*-alkoxy chalkones, that is, the benzyloxy-group has the same activating effect as the ethoxy- or methoxy-group.

80. Rottlerin. Part IV.

K. S. NARANG *and* J. N. RAY, Lahore.

The structure of rottlerin advanced in Part III has been further investigated. Oxidation products with lead tetra-acetate have been chromatographically separated and their structures determined. Chromatographic analysis of kamala extract reveals the presence of six zones. These have been separated.

A pale yellow substance m.p. 180°-181° has been isolated and its relationship with rottlerin discussed.

81. Acridine derivatives. Part II.

B. S. DUGGAN, K. S. NARANG, *and* J. N. RAY, Lahore.

In the present paper some acridines with the 9 position substituted by aminobenzene sulphonamide group has been described. 2-methoxy (or ethoxy) 7-amino 9-piperidino ethyl (or dialkyl-amino-ethyl) acridines have been synthesized.

82. Studies in coumarins.

D. R. KULKARNI, N. M. SHAH, *and* R. L. ALIMCHANDANI,
Dharwar.

Chloralacetoacetic ester $CH_3COCH(CHOHCCl_3)COOEt$ has been condensed with resorcinol, pyrogallol, *o*-, *m*- and *p*-cresols, phloroglucinol, orcinol and 2-acetyl resorcin in the presence of sulphuric acid. In all cases, except *o*- and *m*-cresols the corresponding coumarins have been obtained. *o*- and *m*-cresols gave compounds which are under investigation. On reduction with zinc and acetic acid the $-CHOHCCl_3$ group in the coumarins has been converted into $CH{:}CHCl$. When, however, the reduction is carried out in the presence of HCl, the group $-CHOHCCl_3$ is changed into $-CH_2CHCl_2$. Further work is in progress.

83. Synthesis of coumarins from *o*-hydroxy-aryl alkyl ketones.

D. Chakravarti *and* N. Dutt, Calcutta.

In continuation of the new method of synthesis of coumarin from *o*-hydroxy-aryl alkyl ketones (Chakravarti and Majumdar, *J. Indian Chem. Soc.*, 1938, *15*, 136; *Science and Culture*, 1938, *4*, 64), it has been found that unlike the *o*-methoxy benzaldehydes which give *trans*-cinnamic acids (*o*-coumaric acids), *o*-methoxy acetophenones, e.g., 2-methoxy-3-chloro-5-methyl acetophenone (b.p. 138°/10 m.m.) (A), 2-methoxy-3-methyl-5-chloro-acetophenone (b.p. 136°/8 m.m.) (B), 2-methoxy-4-methyl-5-chloro-acetophenone (b.p. 155°/6 m.m.) (C) readily give highly satisfactory yields of coumarins, e.g., 4 : 6-dimethyl-8-chloro coumarin (m.p. 148°), 4 : 8-dimethyl-6-chloro-coumarin (m.p. 155°) and 4 : 7-dimethyl-6-chloro-coumarin (m.p. 213°) respectively, when condensed with ethyl bromoacetate and the unsaturated ester, thus obtained, is treated in the cold with concentrated sulphuric acid or when heated with hydriodic acid. It is not always necessary to dehydrate the hydroxy ester previously. Similarly (A), (B) and (C) condense with ethyl bromopropionate to produce the unsaturated esters which easily give corresponding coumarin derivatives.

84. Synthetical experiments in the pyrone series: attempted oxidation of chromanones with selenium dioxide.

D. Chakravarti *and* J. Dutta, Calcutta.

The observation of Venkataraman and co-workers (Mahal, Rai and Venkataraman, *J. Chem. Soc.*, 1935, 866; Mahal and Venkataraman, *J. Chem. Soc.*, 1936, 569) that certain flavanones or even some chalkones are oxidized to flavones by SeO_2 led the authors to attempt the oxidation of chromanones with SeO_2 for the unambiguous synthesis of substituted chromones which cannot be synthesized by the methods known at present. The phenoxy propionic acids, prepared from *o*- and *p*-chloro phenol, *o*- and *p*-nitro phenol, *o*- and *p*-cresol and from α- and β-naphthols have been cyclized to the chromanones but attempts to oxidize them with SeO_2 under varying conditions invariably produced selenium complexes. In order to verify the general applicability of Venkataraman's method for the oxidation of flavanones and chalkones, the authors have oxidized with SeO_2 3′ : 4′-dimethoxy-2-hydroxy-5-chloro-chalkone (m.p. 174°), 3′ : 4′-dimethoxy-2-oxy-3-chloro chalkone (m.p. 164°), 3′ : 4′-dimethoxy-2-oxy-3-nitro-5-methylchalkones (m.p. 175°) giving satisfactory yields of 3′ : 4′-dimethoxy-6-chloroflavone (m.p. 194°), 3′ : 4′-dimethoxy-8-chloroflavone (d. 110-111°), 3′ : 4′-dimethoxy-6-methyl-8-nitroflavone (d. 244-245°) respectively. The fact that the chromanones are not oxidized while the chalkones, irrespective of any substituents in the benzene nucleus, undergo smooth oxidation with SeO_2 without the formation of complicated selenium complexes suggests that the phenyl group in pyrone nucleus is responsible for this smooth oxidation.

85. The influence of halogen atom on Kostanecki's reaction in the formation of α- and γ-pyrones.

D. Chakravarti *and* B. Majumdar, Calcutta.

A detailed study of Kostanecki's reaction on the halogenated aceto- and propiophenones, e.g., 5-chloro-3-methyl-2-hydroxy acetophenone and propiophenone, 5-chloro-4-methyl-2-hydroxy-acetophenone and propiophenone, 3-chloro-5-methyl-2-hydroxy-acetophenone and propiophenone, 5-chloro-2-hydroxy propiophenone and 5-bromo-2-hydroxy-propiophenone has revealed no marked influence of the halogen atom towards the formation of the γ-pyrones as observed by Chakravarti in Simonis' reaction. The results are in full agreement with the findings of Heilbron and co-workers (*J. Chem. Soc.*, 1933, 1263; 1934, 1311, 1581; 1936, 295) that coumarins are formed by the action of propionic anhydride and sodium propionate on *o*-hydroxy-acetophenones and by the action of phenyl acetic anhydride and sodium phenyl acetate on *o*-hydroxy acetophenones and propiophenones.

86. Synthesis of coumarino-coumarin, coumarino-chromone and chromono-chromone derivatives.

D. Chakravarti *and* N. Chakravarti, Calcutta.

Derivatives of coumarino-coumarin (A), coumarino-chromone (B) and chromono-chromone (C) have been synthesized from 1 : 5-dioxy-naphthalene (1) . (1) on condensation with acetoacetic ester forms 7-hydroxy-4-methyl-1 : 2-$\alpha\beta$-naphthapyrone (m.p. 284°) (II), which again condenses with another molecule of acetoacetic ester forming a derivative of (A). The acetyl derivative of (II) on Frie's transformation produces 7-hydroxy-8-acetyl-1 : 2-$\alpha\beta$-naphthapyrone (m.p. 302°), which on heating with sodium acetate and acetic anhydride forms a derivative of (B). The diacetyl derivative of (1) on Frie's transformation gives 1 : 5-dioxy-2 : 6-diacetyl-naphthalene (m.p. 222°) and the latter on heating with sodium acetate and acetic anhydride yields a derivative of (C).

87. Studies in hydroxy and methoxy benzoic acids.

H. V. Dharwarkar *and* R. L. Alimchandani, Dharwar.

The condensation products of *o*-, *p*-, and *m*-hydroxy benzoic acids with chloral, viz., 4-hydroxy-5-carboxy-1-α-hydroxy-$\beta\beta\beta$-trichloroethyl-benzene (I), 6-carboxy-2 : 4-bis-trichloromethyl-1 : 3-benzdioxin (II), and 5-hydroxy-trichloro-methyl-phthalide (III), on reduction with zinc and acetic acid give 2-hydroxy-5-$\beta\beta$-dichlorovinyl-benzoic acid (IV), 4-hydroxy-5-$\beta\beta$-dichlorovinyl-benzoic acid (V), and 3-hydroxy-6-$\beta\beta$-dichlorovinyl-benzoic acid (VI) of the general formula R-CH : CCl_2, (R = benzene residue) contrary to the usual formula R-CH_2CHCl_2 obtained from the corresponding methoxy derivatives. On hydrolysis with dilute alkali (IV), (V) and (VI) give 4-hydroxy-5-carboxy-mandelic aldehyde (R-CHOH.CHO), 4-hydroxy-6-carboxy-mandelic aldehyde, and 5-carboxy-2-chlorocoumarone, respectively. The methoxy acids, however, yield ω-chloro-styrenes (R-CH : CHCl). Sulphuric acid converts all the reduction products into the corresponding phenyl-acetic acids (R-CH_2COOH). The tetrachloro-compound (R-$CHClCCl_3$) obtained from (I) reacts with potassium cyanide, potassium iodide, ammonia and aniline giving 4-hydroxy-5-carboxy-1-α-cyano-$\beta\beta$-dichlorovinyl-benzene, 2-hydroxy-5-$\beta\beta$-dichlorovinyl-benzoic acid (identical with IV), 4-hydroxy-5-carboxy-1-α-amino-$\beta\beta\beta$-trichloroethyl-benzene, and 4-hydroxy-5-carboxy-1-α-anilino-$\beta\beta\beta$-trichloroethylbenzene respectively. The methoxy tetrachloro-derivatives, however, are indifferent towards the above reagents.

On hydrolysis with methyl alcoholic potash (II) gives 6-carboxy-2 : 4-bisdichloro-methylene-1 : 3-benzdioxin followed by 6-carboxy-2 : 4-bisdihydroxy-bisdicloromethyl-1 : 3-benzdioxin. (Cf. Chattaway and Prats, *J.C.S.*, 685, 1927).

88. γ-substitution in the resorcinol nucleus. Part III. Synthesis of 2 : 6-dihydroxy 3-ethyl benzaldehyde.

H. A. SHAH *and* R. C. SHAH, Bombay.

Gattermann reaction on methyl 2 : 4-dihydroxy 5-ethyl benzoate by Shah and Laiwalla's method (*Current Science*, 197, 1936) afforded the aldehyde ester, methyl 2 : 4-dihydroxy-3-formyl-5-ethyl benzoate which on hydrolysis gave 2 : 4-dihydroxy-3-formyl-5-ethyl benzoic acid (I). The acid (I) on decarboxylation gave 2 : 6-dihydroxy-3-ethyl benzaldehyde—a γ-resorcylaldehyde derivative.

89. γ-substitution in the resorcinol nucleus. Part IV.

H. A. SHAH *and* R. C. SHAH, Bombay.

Shah and Shah (*Nature*, 163, *142*, 1938), found that some polyhydroxy-phenolic ketones on formylation by the modified Gattermann reaction of Shah and Laiwalla (cf. Shah and Laiwalla, *Current Science*, 197, 1936) afford ketone aldehydes the formyl group entering the usually inaccessible γ-position whenever vacant.

In continuation of the above work respropiophenone and 2 : 4-dihydroxy phenylbenzyl ketone have been formylated by the above method, the products being 2 : 4-dihydroxy-3-formyl-propiophenone and 2 : 4-dihydroxy-3-formyl, phenyl, benzyl, ketone respectively. 2 : 4-dihydroxy 5-ethyl acetophenone on formylation gave 2 : 4-dihydroxy-3-formyl-5-ethyl acetophenone. The above ketone aldehydes have been converted into interesting coumarin derivatives through the Knovenagel reaction.

90. Studies on the substituted amides of cyanacetic acid. Part I. Velocity of saponification of the substituted amides of the cyanacetic acid of the type: $CN.CH_2CONHR$.

K. G. NAIK, R. K. TRIVEDI, *and* H. P. PARIKH, Baroda.

The substituted amides of cyanacetic acid mentioned below were made to react with a standard solution of alcoholic potassium hydroxide in order to study their velocity of saponification. (1) Cyan-acet-methyl anilide. (2) Cyan-acet-anilide. (3) Cyan-acet-*p*-tolyl amide. (4) Cyan-acet-*m*-tolyl amide. (5) Cyan-acet-*o*-tolyl amide. (6) Cyan-acet-1 : 3 : 4-xylidide. (7) Cyan-acet-1 : 4 : 5-xylidide. (8) Cyan-acet-α-naphthyl amide. (9) Cyan-acet-β-naphthyl amide. (10) Cyan-acet-methyl amide. (11) Cyan-acet-ethyl amide. (12) Cyan-acet-benzylamide.

It was found that the velocity of saponification in the above cases would depend on—

(1) the nature of the grouping -NHR according as the nitrogen atom is secondary or tertiary;
(2) the position of the alkyl group or groups as in the case of tolyl, benzyl and such other groups attached to the nitrogem atom;
(3) the molecular weight and the molecular volume of the groups attached to the carbonyl - CO - groups in the above compounds;
(4) the nature of the residues attached to the nitrogen atom as they may be either aliphatic or aromatic.

91. Studies on the substituted amides of the cyanacetic acid. Part II. Preparation of the chloro derivatives of the substituted amides of cyanacetic acid.

K. G. Naik, R. K. Trivedi, *and* H. P. Parikh, Baroda.

The aim of undertaking the above work was to show whether each of the valencies of the carbon atom of the methylene—CH_2 group exerts equal affinity towards the incoming radicals. The results of the reactions show that in some cases monochloro derivatives and in other cases dichloro derivatives were formed, the reaction depending upon—

(1) The nature and concentration of the chlorinating reagent.
(2) The nature of the radicals present in the substituted amides, as for example, in the case of the amides such as CN-CH-CONHR, the nature of R plays a considerable part in producing either the mono- or the dichloro derivatives.

The amides named in Part I gave rise to chloro derivatives of the following three types:—

I. CN-CHCl-CONHR; II. $CN-CCl_2-CONHR$; and
III. CN-CHCl-CONH R′ Cl.

92. Studies on the substituted amides of cyanacetic acid. Part III. The velocity of the replacement of the chlorine atoms by hydrogen in the compounds of the type $CN-CCl_2-CONHR$.

K. G. Naik, R. K. Trivedi, *and* H. P. Parikh, Baroda.

The velocity of replacement of the chlorine atoms from some of the compounds prepared in Part II was studied by reducing the chlorine atoms by means of HI, hydrogen iodide. It has been found out that—

(1) the velocity with which the chlorine atoms are reduced in the case of the chloroderivatives, as well as the velocity of the saponification of the substituted amides, both go to show that the same factors seem to govern the activity of the molecules of the compounds studied herein;
(2) both the chlorine atoms in $CN-CCl_2-CONHR$ do not seem to be held with equal tenacity, a fact which seems to be supported by the uniformity in the velocity of the reduction in the case of the monochloro-cyanacet-ethylamide;
(3) when one of the two chlorines is removed by reduction, the internal condition of the molecule changes and this change may be responsible for the decrease in the velocity of reduction of the other chlorine atom.

93. Benzylidene-coumaranones considered as chalkones.

T. B. Panse *and* T. S. Wheeler, Bombay.

It has been found that benzylidene-coumaranones react as chalkones and condense with (1) aceto-acetic-ester, (2) cyclohexanone, (3) flavanone, (4) desoxybenzoin, and (5) phenyl-hydrazine giving rise to various new ring systems.

94. Enolization of diaroylmethanes.

R. B. Shenoi *and* T. S. Wheeler, Bombay.

A comparative study has been mode of the isoxazoles prepared from the diketones ($R_1CO.CH_2.COR_2$) from the corresponding dibromides ($R_1CO.CHBr.CHBrR_2$) and ($R_2CO.CHBr.CHBrR_1$), and enol ethers ($R_1CO.CH : (OEt)R_2$) and ($R_2CO.CH : CH (OEt)R_1$), in order to obtain, if possible, information regarding the manner in which the diketones enolise.

Derivatives of the following pairs of chalkones form the basis of study:—

(i) *p*-tolyl styryl ketone and phenyl *p*-methyl-styryl ketone, and
(ii) anisyl *p*-methyl styryl ketone and *p*-tolyl *p*-methoxy-styryl ketone.

95. The stereochemistry of pinane and its derivatives.

K. Ganapathi, Bangalore.

A strainless model of the ring system of norpinane is constructed wherein the *cyclo*hexane ring exists in Sachse form and the *cyclo*butane ring is puckered. On the basis of this model, the phenomena of isomerism, stability of various derivatives, ready isomerization of β- to α-pinene, the easy fission of some derivatives to yield *cyclo*hexane compounds and the Wagner rearrangement are explained.

96. Configuration of the 2 : 3-dihydroxytransdecalins.

K. Ganapathi, Bangalore.

Three stereoisomers of 2 : 3-dihydroxydecalin that are theoretically possible are now prepared. 2 : 3-diketo*trans*decalin yields on reduction with sodium amalgam an isomer, m.p. 141° while with aluminium amalgam two other isomers, m.p. 128° and 167°. Δ^2-Octalin on oxidation with permanganate furnishes the isomer, m.p. 141° while the oxide on hydration gives that with m.p. 167°. The configurations of these stereoisomers are discussed.

In the case of 2 : 3-dihydroxytetralin also, wherein the *cyclo*hexane ring is known to be puckered, three such isomers are possible. The three compounds isolated by Leroux are those required by theory though his deductions about the configurations are not correct.

97. Cis-trans conversion of compounds occurring in essential oils by means of selenium dioxide.

B. Sanjiva Rao *and* (Miss) Mary Mathen, Bangalore.

Liquid β-asarone was converted into solid asarone by treatment with selenium dioxide. Complex organo-selenium compounds are sometimes formed during the reaction. Iso-eugenol, iso-eugenol-methyl-ether, oleic acid could be readily converted into their isomers while safrol, maleic and citraconic acids yielded complex products.

98. C-Benzoylation of β-aryl-glutaconic anhydride.

G. R. Gogte, Bangalore.

The β-(4-methoxy-phenyl)-glutaconic anhydride could easily be benzoylated by benzyl chloride and pyridine giving a monobenzoyl-derivative, m.p. 119°C, and a dibenzyl derivative, m.p. 194°C. The β-

(2-methoxy-5-methyl-phenyl)-glutaconic anhydride gives a benzoyl derivative m.p. 158°C. The constitutions and reactions of these derivatives are under investigation.

99. C-Acetylation of β-aryl-glutaconic anhydrides: Formation of αγ-diaceto-β-aryl-glutaconic anhydrides.

G. R. Gogte, Bangalore.

The α-aceto-β-(4-methoxy-phenyl)-glutaconic anhydride (Gogte, *Proc. Ind. Acad. Sci.* (A), *7*, 214–228, 1938), could be further acetylated by acetic anhydride and sodium acetate or by acetyl-chloride and pyridine, giving a diaceto-glutaconic anhydride, m.p. 108°C. The derivative could also be obtained by directly acetylating the β-(4-methoxy-phenyl) glutaconic anhydride under more energetic conditions. This diaceto-derivative titrates as a strong monobasic acid, gives blue colouration with ferric chloride and produces β-(4-methoxy-phenyl)-propylene, m.p. 32°C., by the action of dilute hydrochloric acid, and hence it is thought to be αγ-diaceto-β-(4-methoxy-phenyl)-glutaconic anhydride. The β-(2-methoxy-5-methyl-phenyl)-glutaconic anhydride gave a di-derivative m.p. 168°C. (*Indian Sci. Cong. Abstr.*, pp. 57-58, 1938).

The action of caustic alkali on these αγ-diaceto-β-aryl-glytaconic anhydrides, produces phenolic compounds as well as a mixture of isomeric hydroxy acids, the constitutions of which are under investigation.

100. Isomerization of oleic acid by nickel catalyst.

V. T. Athavale *and* S. K. K. Jatkar, Bangalore.

The measurements of iodine values, refractive indices and dispersions of the hydrogenated products showed that the iodine value varied linearly with refractive index only after the former had dropped down by about 25%, the variation of the refractive index with iodine value in the initial stages being comparatively greater. The dispersions of the hydrogenated products were considerably different for the samples having either the same refractive index or the same iodine value, and depended on the temperature of hydrogenation, marked deviations being observed in the case of samples hydrogenated at low temperatures. It is concluded that there are isomers of oleic acid formed in the reaction owing to the low activity of the catalyst for hydrogenation at lower temperatures.

101. The constitution of oxycellulose and hydrocellulose.

S. R. Ramachandran *and* K. Venkataraman, Bombay.

Previous work from this laboratory on oxycellulose and hydrocellulose (*J. Indian Chem. Soc., Ind. Edn.*, *1*, 36, 1938); *J. Soc. Chem. Ind.*, in print) has been concerned with qualitative tests for their distinction and a rapid method for the estimation of their reducing power. Hydrocelluloses and oxycelluloses have now been prepared by a variety of methods, employing different acids and oxidizing agents for the degradation, in order to study the variations thus produced in chemical character. The carboxylic acid conception of oxycellulose is obviously applicable only to the type which has an increased affinity for basic colours and in which the acidic hydrogen is titratable by the Neale method; the type of oxycellulose, which has a high copper number and a low methylene blue absorption, loses weight considerably by scouring and does not possess an abnormal retentive power for alkali, can only be aldehydic in character. Attention having also been drawn to the ability of oxycellulose to couple with diazo salts and to the consequent hypothesis of a β-ketonic aldehyde or acid structure for such an oxycellulose, degradation of cellulose by means of acids or oxidizing agents or other agencies might result in four kinds of modification in the anhydroglucose chain: (1) Fission of the 1 : 4-glucosidic linkage, with the formation of shorter chains of lower molecular weight and the exposure of a larger number of terminal aldehydic groups. Increase in copper number and in cuprammonium fluidity would follow, but in other respects, such as the behaviour towards dyestuffs and diazo salts, the product would resemble standard cellulose, except for differences due to the reduction in the molecular size. This may be regarded as hydrocellulose. (2) Oxidation of some of the primary alcoholic groups to aldehydic groups. (3) Oxidation of the latter or the terminal aldehydic groups to carboxylic groups. (4) Oxidation of some of the secondary alcoholic groups β- to the aldehydic or carboxylic groups to carbonyl. Fission of the 1 : 4-glucosidic linkages as in (1) may in general be assumed to precede the other reactions, although this would be a theoretical requirement only in the case of (4). The three types of oxycellulose so far distinguished would be represented by (2), (3) and (4), but it is important to note that two or more of the changes pictured in the four reactions indicated above may proceed simultaneously or successively, leading to mixed types of the modified celluloses. Qualitative and quantitative studies on these lines are in progress.

102. On the constitution of tambulin.

P. K. Bose, Calcutta.

From the fruits of *Zanthoxylum acanthopodium* DC a yellow crystalline flavone, m.p. 205°, called tambulin, has been isolated in poor yield. Analytical and other data agree with the formula $C_{15}H_5O_2(OH)_2(OCH_3)_3$. The constitution of tambulin is discussed.

103. The sulphonation of monoethylaniline.

I. S. Uppal *and* K. Venkataraman, Bombay.

While preparing certain wetting agents by condensing oleic acid with N-methylsulphanilic acid, the constitution of the latter as the para compound was assumed. In view of the somewhat conflicting nature of the existing evidence regarding the three monomethylaniline sulphonic acids, proof of their orientation was adduced in a recent communication to the *J. Soc. Chem. Ind.*

Sulphonation of monomethylaniline led, according to the conditions of sulphonation, to N-methylsulphanilic acid or a mixture of this acid with N-methylmetanilic acid. N-Methylorthanilic acid was obtained by the methylation of orthanilic acid with dimethyl sulphate. The three monomethylaniline sulphonic acids were characterized as the arylamine salts of their *p*-toluenesulphonyl derivatives, the latter being prepared both by treating the monomethylaniline sulphonic acids with *p*-toluenesulphonyl chloride and by the N-methylation of *p*-toluenesulphonyl-sulphanilic, metanilic and orthanilic acids.

Studying the sulphonation of monoethylaniline and the N-ethylation of *p*-toluenesulphonyl-sulphanilic, metanilic and orthanilic acids on parallel lines, it was found that the sulphonation proceeded exactly as in the case of monomethylaniline.

104. Studies in the naphtol AS series. Part III. Synthetical experiments. I.

R. V. Bhat, R. B. Forster, *and* K. Venkataraman, Bombay.

Reference has been made in earlier communications (Forster, Mehta and Venkataraman, *J. Soc. Dyers Col.*, *54*, 209, 1938; Forster, Ramachandran and Venkataraman, *ibid.*, 216) to the relation between the substantivity towards cotton of members of the naphtol AS group and the kier boiling and rubbing fastness of the dyeings derived from them. While it was shown that substantivity and fastness to kier boiling and rubbing did not necessarily run parallel, substantivity is undoubtedly a desirable property.

A series of new naphthols have been synthesized, the main objective of the synthetic experiments being to introduce the specific groupings which are known to impart to an organic compound the special property of substantivity towards the cotton fibre. Thus, on the analogy of naphtol AS-BR, 2-hydroxy-3-naphthoic acid has been condensed in the known manner with symmetrically constituted diamines such as benzidine, tolidine, 4 : 4′-diaminodiphenyl-methane and 4 : 4′-diaminodiphenylamine. Since the acylamido group (-CO-NH-), exemplified by naphtol AS itself in contrast to β-naphthol, is a factor leading to increased substantivity, naphthols have been prepared containing a second -CO-NH- group by condensing hydroxynaphthoic acid with bases such as 4-benzoylamido-2 : 5-diethoxyaniline (Fast Blue Base BB), 3-amino-4-methoxy-6-benzoylamidotoluene (Fast Violet Base B) and 2 : 4-dimethyl-5-benzoylamidoaniline (Fast Red Base RBE). The influence of a double bond conjugated with the carboxyl has been illustrated by the use of *p*-cinnamoylamidoaniline.

The sulphur atom in an organic compound is favorable to substantivity. From this point of view and of the influence of the *p*-toluenesulphonyl group on fastness (*cf.* the Polar colours), naphthols containing the *p*-toluenesulphonylamido and phenyl *p*-toluenesulphonate groups have been prepared. On account of the positive character of the imide hydrogen in the former, such a naphthol may couple with two molecules of a diazo salt or, alternatively, may be capable of improvement in the fastness of the dyeings by after-treatment with copper and chromium salts. A third example of a sulphur-containing naphthol was the hydroxy-naphthoyl derivative of dehydrothiotoluidine.

A new type of naphthol has been obtained by the interaction of 2-hydroxy-3-naphthoyl chloride with the aminoanthraquinones. On the one hand these are vat colours similar to Algol Yellow R (Indanthrene Yellow GK) and Indanthrene Brilliant Violet RK and on the other they are naphthols capable of coupling in the normal way with diazo salts. The substances may thus be applied to cotton as vat colours and after-treated on the fibre with diazo salts. Finally naphthols with basic properties, which should lead to dyeings of augmented brightness and should be applicable in conjunction with the usual mordants for basic colours, have been synthesized by the condensation of hydroxynaphthoic acid with *p*-amino-dialkylanilines and with α-amino-pyridine.

The *p*-toluenesulphonyl derivatives of naphtol AS and its analogues are useful for characterizing the naphthols and may prove of interest with regard to their application in printing.

105. The reaction of some aromatic diamines with ethyl malonate.

T. N. MEHTA *and* V. B. THOSAR, Bombay.

The reaction of ethyl malonate with benzidine, tolidine and *p*-phenylenediamine has been studied varying (i) the concentration of reacting substances, (ii) the temperature of the reaction, and (iii) the medium of reaction. Ethyl malonate (3 mols.) and benzidine (1 mol) when heated at 115°–120°C. for about 10 hours give rise to ethylmalon-4′-amino-diphenylamate (I), diethylmalon-diphenyl-amate (II) and diethylmalon-di-diphenylamide (III). The higher temperature and less proportion of ester gives more yield of III, while at lower temperatures with excess of ester the yield of I increases. I, on heating in an oil bath at its melting point, i.e. 140°C, gradually decomposes giving II, III and benzidine, while if it is heated in presence of boiling xylene for about ten hours, only III is obtained. Tolidine and malonic ester give only diethylmalonditolyl-amate (IV) and an insoluble substance (V). The reaction of ethyl malonate and *p*-phenylene-diamine gives diethylmalon-*p*-phenylene-amate (VI), ethylmalon-*p*-acetylamino-phenylamate (VII) and a blue mass practically insoluble in all organic solvents. When heated in presence of an inert solvent like boiling xylene ethylmalonate and *p*-phenylene-diamine give VI, VII and blue mass but in a form which could be readily purified. VI on heating in an oil bath at it melting point gives VII and a compound of empirical formula $C_{11}H_{10}O_3N_2$ probably *p*-acetylamino phenyl-malon-imide (VIII), while if VI is heated in presence of boiling xylene only VII is obtained. The acids obtained by hydrolysis of II and VI on decarboxylation give diacetyl benzidine and diacetyl-*p*-phenylene diamine respectively.

106. Halogenation. Part XXIII. Halogenation of 2 : 6 dimethylnaphthalene.

P. S. VARMA *and* S. SRINIVAS RAO, Benares.

Chlorination, bromination and iodination of 2 : 6-dimethylnaphthalene have been carried on in presence of different halogen carriers in the dark, in sunlight and in diffused daylight and also at different temperatures. Two mono- chloro-derivatives, one liquid boiling at 285° and one solid melting at 137-137°, three bromo-derivatives, one mono-, one di- and one tri-bromo-derivative and only one mono-iodo-derivative, 1-iodo-2 : 6-dimethylnaphthalene, have been obtained in good yields.

107. Halogenation. Part XXIV. Halogenation of acenaphthene.

P. S. VARMA *and* K. SUBRAMANIAN, Benares.

Acenaphthene has been chlorinated, brominated and iodinated under different conditions as a result of which several chloro-, bromo-, and iodo-derivatives, some of which have been prepared before by indirect methods only, have been obtained by direct halogenation. All attempts to prepare mixed halogen derivatives of acenaphthene has failed uptil now. Nitration of mono-halogen derivatives has also been carried on and some nitro-halogen derivatives have been obtained in good yields, but the reduction of these nitro-derivatives has resulted in a very poor yield of the corresponding amino-halogen derivatives so that these amino-halogen derivatives could not be obtained in sufficiently large quantities for the preparation of the mixed halogen derivatives by replacement of the amino group by a halogen atom.

108. Extension of the Nidhone process for the syntheses of 2-acyl-resorcins to 2-acyl-4-alkyl-resorcins. Part I. Synthesis of 2-acetyl-4-ethyl-resorcin.

S. D. LIMAYE, Poona.

The Nidhone process (Limaye, *Ber.*, *67*, 12, 1934) has been applied to the syntheses of numerous 2-acyl-resorcins both of the aliphatic and aromatic series by D. B. Limaye and co-workers. It could be extended to the syntheses of 2-acyl-4-alkyl-resorcins. Thus 2-acetyl-4-ethyl-resorcin, previously obtained by Rosenmund *et al* by the reduction of 2 : 4-diacetyl-resorcin in the presence of palladium (*Chem. Zentr.*, 1933, II, 1515), has now been synthesized from 4-ethyl-resorcin, through 6-ethyl-4-

methyl-umbelliferone (I) m.p. 211°, 6-ethyl-4-methyl-umbelliferone acetate (II) m.p. 143° and 8-acetyl-6-ethyl-4-methyl-umbelliferone (III) m.p. 136-37°.

The constitution of compound (I) has been proved by its identity with the reduction product of 6-acetyl-4-methyl-umbelliferone (Limaye, *Ber.*, *65*, 375, 1932; Limaye and Gangal, *Rasāyanam*, *1*, 65, 1936); and (III) gave on reduction, 6 : 8-diethyl-4-methyl-unbelliferone (Limaye and Limaye, *Rasāyanam*, *1*, 109, 1937).

109. The alkyration of 2-methyl-, 3-methyl and 4-methyl-cyclohexylidene cyanoacetates.

R. D. DESAI *and* G. S. SAHARIYA, Aligarh *and* Bombay.

These cyanoesters were prepared in the course of the synthesis of 4-methyl and 3-methylcyclohexane-1 : 1-dicarboxylic acid, and were found to undergo methylation in the β-γ-forms. Other chemical properties of these α-β-unsaturated esters have been studied.

110. On 2-phenyl-4-amino-quinoline derivatives.

U. P. BASU *and* P. DAS GUPTA, Calcutta.

The recent researches in chemotherapy have revealed that a dialkyl amino-alkyl chain plays a considerable part in the development of therapeutic activity in certain quinolines or benzo-quinolines. As various derivatives of 2-phenyl-quinoline-4-carboxylic acid are again being largely used in medicine, it was considered to be of interest to make a study on the class of compounds that might be obtained by the linking of a dialkyl amino-alkyl chain or any other suitable group with 2-phenyl-4-amino-quinoline.

Accordingly, the 4-carboxylic group of the drug 'atophan' was converted to the amino-group to afford 2-phenyl-4-amino-quinoline by the customary method. This was then condensed with diethylamino-ethyl bromide to give 2-phenyl-4-(β-diethyl amino-ethyl-) amino-quinoline as a viscous yellow oil, b.p. 272–76°/6 mm., η_{31} = 1·6510, and forming a picrate which crystallizes from a large volume of alcohol in clusters of yellow needles, m.p. 238-39°C. Similarly the diethyl amino-propyl chloride yielded 2-phenyl-4-(γ-diethyl amino-propyl-) amino-quinoline distilling at 265–70°/6 mm., and forming a picrate, m.p. 234°C. Again 2-phenyl-4-amino-quinoline has also been condensed with 4-acetyl amino-benzene sulphonyl chloride to afford 4-acetyl amino-benzene-sulphon-2′-phenyl-4′-quinolyl amide, m.p. 297° on crystallization from alcohol.

The bacterial and the bacteriostatic properties of the compounds particularly against pneumococci are being studied.

111. On the stability of oils.

U. P. BASU *and* A. MAZUMDER, Calcutta.

It is generally known that a vegetable or marine oil containing an unsaturated linkage in the molecule undergoes a chemical change by the formation of peroxide and its subsequent decomposition to aldehydes and acids. This change generally gives rise to the rancidity and acidity of the oil. For commercial application of any of this oil this change will have to be inhibited and it is now being found that certain vegetable oils contain substances which act as good antioxidants to vegetable and marine oils. The work is in progress to find out the characteristic of these substances as well as the minimum amount that is required in arresting the change in the oil when particularly exposed to atmospheric oxidation.

112. Reactivity of aryl-*o*-alkoxystyryl ketone dibromides.

N. A. Bhagwat *and* T. S. Wheeler, Bombay.

2-methoxy benzaldehyde has been condensed with acetophenone and *p*-methyl acetophenone to give the respective chalkones. These have been converted into the dibromides. The *B*-bromine atom in these dibromides is liable and they can be employed in the synthesis of both flavones and benzylidene coumaranones. These dibromides have also been converted with alcoholic alkali into the enolic ethers of the corresponding dibenzoyl ethanes and these yield flavones with hydrogen bromide in glacial acetic acid. This method avoids the use of the difficulty obtainable *o*-hydroxy acetophenones as intermediates in the production of flavones. The bromine atom in the bromodibenzoyl methanes is strongly positive and is readily replaced with hydrogen.

113. Experiments on the synthesis of podophyllotoxin and podophyllin.

B. S. Duegan, K. S. Narang, *and* J. N. Ray, Lahore.

Piperonyl chloride has been condensed with sodio-malonic ester and the product converted into its sodio-derivative. The latter has been condensed with bromo-malonic ester and the constitution of the resultant substance determined by oxidation.

Trimethyl galloyl chloride has been condensed with veratrole. The pentamethoxy benzophenone unergoes Reformatsky condensation with bromo-malonic ester. The unsaturated phase isolated from the carbinol has been reduced.

114. Cane wax I. Non-saponifiable matter of the wax.

N. L. Vidyarthi *and* M. Narasinga Rao, Waltair.

The non-saponifiable matters of the wax from Co. 213 cane have been subjected to the phthallic anhydride treatment according to the methods of Chibnall *et al.* (*Biochem. J.*, *25*, 2095, 1931). The primary alcoholic portion consists of myricyl alcohol, the secondary alcoholic portion consists of a mixture of sterols from which brassicasterol was seperated by bromination of the acetate of the mixture and from the mother liquor sitosterol was isolated. It also contains a paraffin which melts at 75°C. and by molecular weight it seems to contain 35-carbon stoms. The non-saponifiables contain about 80% of primary alcohol, which is mainly myricyl alcohol, 5% of hydrocarbon and 15% of a mixture of sterols. Further study on the nature of the sterol mixture is going on.

115. Cane wax II. Composition and consitution of the fatty-acids of the wax.

N. L. Vidyarthi *and* M. Narasinga Rao, Waltair.

The fatty acids of the cane wax have been subjected to an exhaustive study. The fatty acids were isolated into the individual acids by lead sat alcohol and ether method and fractional distillation under reduced pressure of 1 mm. The wax as a whole contains 53% of acidic material out of which 2·35% is resinous acid and 50·65 fatty acids. The proportions of the several fatty acids in the wax are 0·34% caproic acid, 14·7% palmitic acid, 11·84% stearic acid, 22·4% unsaturated octodecenoic acid and 1·75% of arachidic acid. The position of the double bond in the octodecenoic acid has been determined by oxidation with potassium permanganate in acetone and it has been found to be $\Delta^{9:10}$ octodecenoic acid (ordinary oleic acid).

116. Bridging of succinosuccinic ester: On synthesis of compounds of tricyclene type.

P. C. Guha, Bangalore.

The compounds of tricyclene type occur in sesquiterpenes like santalol. Tricyclene has been obtained from a number of derivatives of compounds of the camphane group and also from teresantalic acid; but no direct synthesis of any tricyclic compound of this type has yet been effected.

Some suitable derivatives of bridged succinosuccinic ester have given compounds which are supposed to possess structure resembling that of tricyclene. The results are being confirmed.

117. Action of aliphatic diazo-compounds on cyclic conjugated double bonded systems.

P. C. Guha *and* G. D. Hazra, Bangalore.

It has been shown that the aliphatic diazo-compounds react with cyclic hydrocarbons possessing a system of conjugated double bonds in 1 : 2-positions, but not in 1 : 4-positions (*Sci. Cong. Chem. Abst.*, 1938, paper No. 110).

To study the influence of negative groups like 'COOEt' or 'CO' adjacent to 1 : 4-carbon atoms in the conjugated double bonded system, on the addition of diazomethane and diazoacetic ester, etc., benzoquinone and $\Delta^{1:3}$-dihydroterephthalic ester have been condensed.

o-Benzoquinone in ethereal solution at —15° reacts very vigorously with diazomethane yielding a deep brown mass from which no definite compound could be isolated. Tetrabromo-benzoquinone did not react with diazomethane.

Dimethyl terephthalate was catalytically reduced to hexahydroterephthalic ester, and the latter converted to 1 : 4-dibromo-hexahydroterephthalic ester. $\Delta^{1:3}$-Dihydroterephthalic ester was prepared from the dibromo ester. It reacts readily with diazomethane and the product was freed from nitrogen at 140°, the resulting compound boiling at 132–136°/2-3 mm. A solid crystalline substance, m.p. 103-4°, separates out of the liquid, on standing. The residual liquid boils at 132–134°/2-3 mm. and agrees in composition with the expected 1 : 4-bridged compound. The structure is being confirmed.

118. Synthetic textile auxiliaries. Part I. α-sulphonates of fatty acids and their substituted amides.

T. N. Mehta *and* D. M. Trivedi, Bombay.

The aliphatic fatty acids (C_{12}–C_{18}) brominated in presence of red phosphorus are reacted with alcoholic sodium sulphite to give the α-sodium sulphonates of the fatty acids and their substituted amides. The compounds:—(1) palmitic acid-α-sodium sulphonate, (2) disodium α-sulpho-palmitate, (3) palmitamide-α-sodium sulphonate, (4) palmitanilide-α-sodium sulphonate, (5) stearamide α-sodium sulphonate, (6) N-methyl-stearamide-α-sodium sulphonate, (7) myristamide α-sodium sulphonate, (8) lauramide α-sodium sulphonate are prepared. The wetting power of these compounds is studied by (1) Herbig number, (2) the time of sinking for a piece of wool, and (3) drop number. It is found that wetting power in case of wool as determined by time of sinking for compounds of homologous series increases from compounds of lauric acid to those of stearic acid, while in case of cotton it decreases from compounds of lauric acids to compounds of stearic acid as shown by Herbig numbers. The effect of substitution of the hydrophilic groups in case of wool is to decrease the wetting power while in case of cotton wetting power is promoted by increasing the number of hydrophilic groups and consequently increasing the solubility. The effect of blocking the free carboxyl group on wetting power appears to be favourable. The introduction of the methyl group (-CH_3) tends to increase the wetting power of the compound while the effect of increasing the molecular weight has a tendency to depress the wetting power of the compound.

119. Synthetic textile auxiliaries. Part II. α-pyridinium compounds of fatty acids and their substituted amides.

T. N. Mehta *and* D. M. Trivedi, Bombay.

The α-bromo fatty acids and their amides are reacted with pyridine to give the α-pyridinium compounds. The compounds:—(1) palmitamide α-pyridinium bromide, (2) palmitanilide-α-pyridinium bromide, (3) stearamide α-pyridinium bromide, (4) myristamide α-pyridinium bromide, and (5) lauramide α-pyridinium bromide are prepared. It appears from the wetting power, studied by Herbig number, time of sinking for a piece of wool and drop number, of these compounds in homologues series, that the wetting power, in case of both cotton and wool, increases from compounds of stearic acid to those of lauric acid. The effect of increasing the molecular weight has a tendency to decrease the wetting power. Extending the application of these compounds to dyeing it is found that when the substantive dyeings are aftertreated with α-pyridinium compounds, dyeings considerably fast to water result. The substantive dyes from yellow to blue are selected for such trials. The effect of the pyridinium compounds on the degree of retardation of the basic dye on wool appears to be great as determined quantitatively by titanous chloride. When applied to the stripping of azoic dye these compounds work equally well like Lissolamine A (I.C.I.). It is also found that wool is dyed a deeper shade with acid colour from a neutral bath in presence of the α-pyridinium compounds and a similar effect, though less marked, is also observed in case of Neolan and Palatine Fast Colours.

120. Synthesis of lauralonic acid.

P. C. Guha *and* V. Rama Iyer, Bangalore.

Lauralonic acid is a degradation product of camphor and has not yet been synthesized. As the first step towards its synthesis, the preparation of diethyl α : β : γ-trimethyl-β-hydroxyadipate was taken up and the following three methods tried. α-Methyl-β-brombutyric ester (prepared by different methods) was made to react with ethyl acetoacetate in presence of zinc (Reformatsky) and magnesium (Grignard) without success. β-Brombutyric ester was then condensed with methyl acetoacetic ester in presence of magnesium (Grignard) and the diethyl α : β : γ-trimethyl-β-hydroxyadipate was obtained as a viscous oil (b.p., 135–137°/5 mm.). Cyclization of the di-ester and reduction to lauralonic acid are in progress.

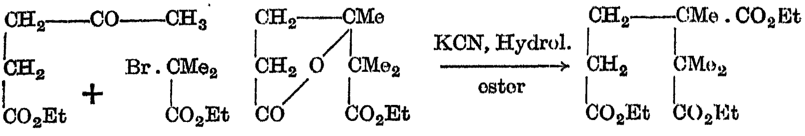
121. On synthesis of homocamphoronic and camphononic acids.

P. C. Guha *and* K. S. Subramanian, Bangalore.

Ethyl α : α : β-trimethyl-β-hydroxy-adipate and the corresponding γ-lactonic ester have been prepared from lævulinic ester and α-brom-

*iso*butyric ester. It was possible, however, to obtain the hydroxy ester from the lactonic ester through the silver salt.

By the action of KCN on the lactonic ester (I), subsequent hydrolysis and esterification, the ethyl ester of *dl*-homocamphoronic acid (II) has been obtained.



(I) (II)

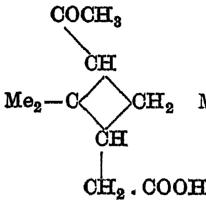
Conversion of (II) into camphononic acid is in progress. It is significant to note that the synthesis of camphononic acid will amount to another total synthesis of camphor.

122. Synthetical experiments in the pinane group. Experiments towards the synthesis of pinonic acid.

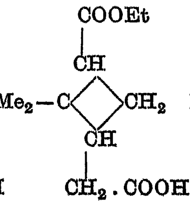
P. C. Guha *and* P. L. Narasimha Rao, Bangalore.

In continuation of our work on the synthesis of pinonic acid (I) (*Ber.*, *71*, 1591, 1938), a tertiary alcohol (III) has been obtained from the mono-ester (II) by a Grignard's reaction. Dehydration of the compound (III) appears to have furnished an unsaturated compound, probably of the constitution (IV).

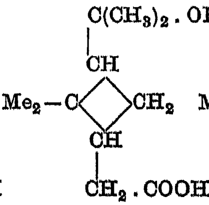
Experiments are in progress in order to confirm structure (IV) as also the oxidation of the unsaturated compound to pinonic acid (I).



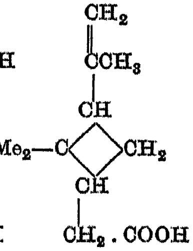
(I)



(II)



(III)



(IV)

123. Synthetical experiments in the pinane group. The configuration of α-bromopinic acid and α-hydroxypinic acid.

P. C. Guha *and* P. L. Narasimha Rao, Bangalore.

The configuration of pinic acid obtained by the degradation of α-pinene, as also of the synthetic product, was shown by Guha and Ganapathi (*Ber.*, *70*, 1505, 1937), to be *trans*. As this acid gives rise only to *cis*-norpinic acid by degradation via. bromopinic acid (II) and hydroxypinic acid (III), it was sought to be elucidated at what stage the conversion of *trans* into *cis* form takes place.

Acids II and III have been prepared in considerable quantities. Experiments are now in progress to establish the configurations of the acids II and III by converting them into pinic acid (Ia) and brompinic acid (II*a*) respectively, and comparing the configurations of the latter acids with those of I and II.

$$\begin{tikzcd} \textit{trans}\text{-Pinic Acid (I)} \arrow[r] & \text{Bromopinic acid (II)} \arrow[r] & \text{Hydroxypinic} \\ \text{(I}a\text{)} & \text{(II}a\text{)} \arrow[l] & \text{acid (III)} \arrow[l] \arrow[d] \\ & & \textit{cis}\text{-norpinic acid.} \end{tikzcd}$$

124. Synthesis of pyrene.

N. N. Chatterjee *and* G. N. Barpujari, Calcutta.

Ethyl 2-carbethoxy cyclohexanone-2-acetate (b.p. 168°–175°/11 m.m.) obtained by the action of ethyl chloroacetate on ethyl cyclohexanone-2-carboxylate is transformed into ethyl-6-carbethoxy cyclohexanone-2-acetate (b.p. 180°–185°/10 m.m.) by boiling with alcoholic sodium ethoxide. A second acetic acid residue is then introduced in the usual manner to yield ethyl-6-carbethoxy cyclo-hexanone-2 : 6-diacetate (b.p. 195°/ 3 m.m.). This ester after hydrolysis (acid m.p. 188°) and esterification yields diethyl cyclohexanone-2 : 6-diacetate (b.p. 165°–175°/5 m.m.). Diethyl cyclohexanone-2 : 6-diacetate undergoes Grignard's reaction with phenyl magnesium bromide to yield a product which after dehydrogenation and subsequent ring closure is expected to yield the required pyrene derivative. Pyrene itself will be obtained by the dehydrogenation of the final product.

125. Synthesis of β-isopropyl glutaconic acid.

S. K. Ranganathan, Bangalore.

β-*iso*Propyl glutaconic acid has been synthesized in continuation of the work on the synthesis of degradation products of the thujane group of bicyclic terpenes (Ranganathan, *J. Indian Chem. Soc.*, 1936, *13*, 419). Ethyl *iso*butyryl-acetate, b.p. 72°/3 mm. condensed with ethyl potassio-cyano-acetate under certain conditions to yield ethyl α-cyano-β-*iso*-propylglutaconate, b.p. 145°/3 mm. The latter on boiling with hydrochloric acid yielded a mixture of the hydrochloride of 1-*iso*propyl-3 : 5-dihydroxy pyridine, and β-*iso*pyropyl glutaconic acid. The free base had m.p. 210° (mono-alcoholate, m.p. 165°). The acid, which is presumably of *trans* configuration, melted at 142°. Its conversion into its *cis* isomer is under way.

126. Synthesis of carane.

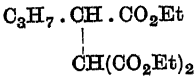
P. C. Guha *and* D. K. Sankaran, Bangalore.

Ethyl Δ^1—tetrahydro-*p*-toluate prepared in an improved yield according to the method of Bardhan (J.C.S., 1935, 478) was condensed with dimethyldiazomethane, by keeping for three weeks at 0°, to yield a bicyclic compound, a bi*cyclo*-(0 : 1 : 4)-heptane derivative. The corresponding acid obtained from the ester by hydrolysis (m.p., 104-105°) gave on distillation with ZnO-BaO under reduced pressure carane b.p., 162°/684 mm., $n_D = 1{\cdot}4553$; d^{26}_{26}, 0·836; the corresponding values of carane as given by Semmler and Feldstein, b.p., 166°/750 mm.; $n_D = 1{\cdot}4582$; d^{20}_{20}, 0·8381.

127. A new method of synthesis of umbellularic acid.

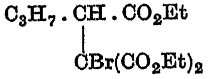
P. C. Guha *and* M. S. Muthanna, Bangalore.

Umbellularic acid, a degradation product of the naturally occurring bicyclic ketone, umbellulone, has recently been synthesized by two methods (*J.C.S.*, 1936, 829; 1936, 828; *J. Indian Chem. Soc.*, 1936, *13*, 419). It has now been synthesized starting from ethyl α-*iso*propyl-α′-carboxysuccinate (I) which readily gives the bromo compound (II) (b.p. 155-56°/3 mm. Found: Br, 21·40%. Calc. Br, 21·86%). The bromo compound loses a molecule of HBr by the action of diethyl aniline yielding ethyl *iso*propyl carboxyfumarate (III) (b.p. 135–40°/3 mm.) which adds on a molecule of diazomethane to yield *cyclo*propane-tricarboxylic ester (IV) (b.p. 148–50°/3 mm.) Found: C, 59·46; H, 8·34; Calc. C, 60·0; H, 8·0%). The tri-ester on being boiled with 18% HCl during 8 hours got hydrolyzed and decarboxylated giving *trans*-umbellularic acid (V) (m.p. 190–92°; Found: C, 55·63; H, 7·26; Calc. C, 55·61; H, 7·0%). The *trans*-acid has been converted to *cis*-variety (monohydrate m.p. 94-95°) with acetyl chloride and its identity proved by taking mixed m.p. with a genuine sample obtained by older method.



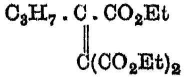
$$\begin{array}{l} C_3H_7\,.\,CH\,.\,CO_2Et \\ \quad | \\ CH(CO_2Et)_2 \end{array}$$

(I)



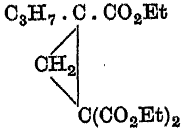
$$\begin{array}{l} C_3H_7\,.\,CH\,.\,CO_2Et \\ \quad | \\ CBr(CO_2Et)_2 \end{array}$$

(II)

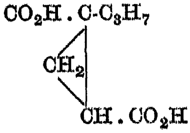


$$\begin{array}{l} C_3H_7\,.\,C\,.\,CO_2Et \\ \quad \| \\ C(CO_2Et)_2 \end{array}$$

(III)



(IV)



(V)

128. Attempts towards synthesis of thujadicarboxylic acid and thujaketonic acid.

P. C. GUHA *and* M. S. MUTHANNA, Bangalore.

The method developed in the preceding abstract for the synthesis of umbellularic acid was followed with an object to synthesize thujadicarboxylic acid starting from ethyl β-*iso*propyl-α′-carboxyglutarate (vide *Proc. Ind. Sci. Cong., Chem. Abst.*, 1937, p. 71). Though the compound (III) obtained from (II) by diethylaniline responded to tests of unsaturation, the product obtained from (III) by the action of diazomethane yielded on hydrolysis and decarboxylation a compound which was proved to be identical with β-*iso*propyl glutaric acid (m.p. 96-97°; eq. wt., 88·62).

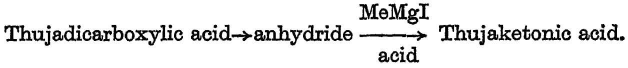
The synthesis of thujaketonic acid was also attempted by a similar scheme starting from ethyl α-acetyl-β-*iso*propyl glutarate prepared by condensing sodioacetoacetic ester with ethyl β-bromo-*iso*caproate.

The product could not be distilled undecomposed and the semi-solid distillate from its colouration (violet) with $FeCl_3$ and combustion values appears to be 3-carbethoxy-4-*iso*propyl-2 : 6-diketono-*cyclo*hexane.

129. Researches on total synthesis of thujone.

P. C. GUHA *and* M. S. MUTHANNA, Bangalore.

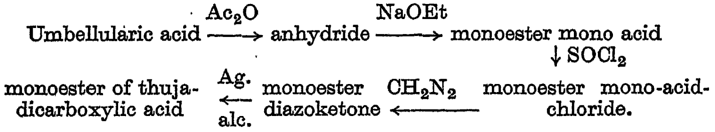
Ruzicka and Koolhaas (*Helv. Chem. Acta.*, 1932, *15*, 944) effected the partial synthesis of thujone starting from thujaketonic acid—a direct degradation product of thujone. Attempts described in the foregoing abstracts, on the synthesis of thujadicarboxylic acid and thujaketonic acid, not proving very hopeful, it was planned to effect a total synthesis of thujone starting from umbellularic acid via. thujadicarboxylic acid and thujaketonic acid. Thujadicarboxylic acid (m.p. 145-46°), prepared from thujone via. thujaketonic acid (m.p. 74-75°) has been successfully converted into thujaketonic acid according to the following scheme:—



$$\text{Thujadicarboxylic acid} \rightarrow \text{anhydride} \xrightarrow[\text{acid}]{\text{MeMgI}} \text{Thujaketonic acid.}$$

The m.p.'s of the synthetic thujaketonic acid and its semicarbazone are 74-75° and 184-85° respectively, remaining undepressed when taken mixed with genuine samples.

The next step for achieving the total synthesis of thujone lies in the conversion of umbellularic acid into thujadicarboxylic acid. The following scheme of research is being worked out to achieve this end:—

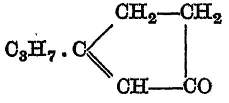


$$\begin{tikzcd}
\text{Umbellularic acid} \arrow[r, "Ac_2O"] & \text{anhydride} \arrow[r, "NaOEt"] & \text{monoester mono acid} \arrow[d, "SOCl_2"] \\
\text{monoester of thujadicarboxylic acid} & \text{monoester diazoketone} \arrow[l, "Ag."', "alc."] & \text{monoester mono-acid-chloride.} \arrow[l, "CH_2N_2"']
\end{tikzcd}$$

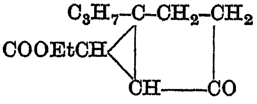
130. On synthesis of sabina ketone.

P. C. Guha *and* M. S. Muthanna, Bangalore.

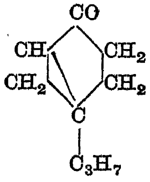
Sabina ketone, a bicyclic ketone of the thujane group, is a product of oxidation of the naturally occurring hydrocarbon sabinene via. sabinenic acid. From the successful results obtained in this laboratory in the synthetic investigations by the application of diazomethane, it seemed very promising that tanacetophorone (I) will form a very convenient starting material for the synthesis of sabina ketone in one operation by the action of diazomethane. Diazomethane could not be induced to react with tanacetophorone even by allowing them to stand together during a fortnight in an ice chamber. Diazoacetic ester has, however, reacted with tanacetophorone at 60° during an hour. The product which is expected to be (II) will furnish sabina ketone (III) on hydrolysis and decarboxylation.



(I)



(II)



(III)

131. Synthesis of bicyclo-(2 : 2 : 2)-octane-(1 : 4)-dione.

P. C. Guha *and* C. Krishnamurthy, Bangalore.

It was reported last year (*Proc. Ind. Sci. Cong., Abst.*, 118, 1938) that the tetra-ethyl ester of hexane-1 : 2 : 5 : 6-tetracarboxylic acid on treatment with sodium gave rise to two products, one soluble in alkali and the other insoluble.

The alkali insoluble portion gives a semicarbazone, m.p., 240–42°. The alkali soluble portion on hydrolysis and decarboxylation gives rise to two interesting products, (i) a neutral diketone, m.p. 205-206°C., and (ii) a ketonic acid, m.p. 201-203°C.

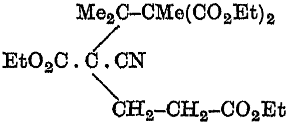
The neutral ketone has been proved to be bi*cyclo*-(2 : 2 : 2)-octane-(1 :4)-dione by the analysis of its semicarbazone (m.p. 244-45°C.) and from the combustion values of the ketone as also from its molecular weight determination (Found: 134·5, 142. $C_8H_{10}O_2$ requires 138). Conversion of the diketone into the corresponding hydrocarbon *bicyclo*-(2 : 2 : 2)-octane is under progress.

132. On the synthesis of 2 : 2 : 3-trimethyl-cyclohexan-4-one-1-carboxylic acid.

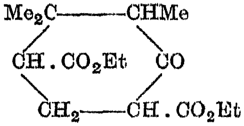
P. C. Guha *and* D. Das Gupta, Bangalore.

2 : 2 : 3-Trimethyl*cyclo*hexan-4-one-1-carboxylic acid (III) is formed from camphorquinone by the action of sulphuric acid, involving Wagner rearrangement but presenting certain peculiarities. The synthesis of this acid has been undertaken with a view to settling the correctness or otherwise of the formula (III), as ascribed to it. As the first step towards the synthesis of this compound, ethyl α-cyano-ββ-dimethyl glutarate was prepared from ethyl-ββ-dimethylacrylic ester and sodiocyanacetic ester. The sodium atom in the α′-position of this product could not be replaced by 'methyl' and hence this method had to be abandoned.

Isopropylidene malonic ester has been condensed with sodium derivative of ethyl α-cyanglutarate and the product methylated to give rise to compound (I). Conversion of compound (I) to α-methyl-ββ-dimethyl-γ-carboxypimelic acid and cyclisation of the ester to compound (II) is in progress. Compound (II) on hydrolysis and decarboxylation will, it is expected, yield the desired compound (III).



(I)



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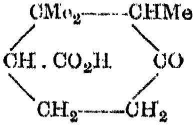
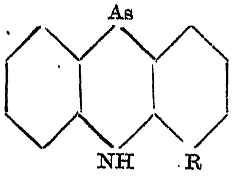


(III)

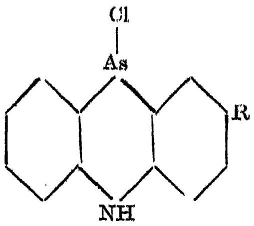
133. Synthesis of methoxy and ethoxy phenarsazines.

P. S. Varma *and* K. S. Venkat Raman, Benares.

Compounds, having methoxy and ethoxy groups in the phenarsazine nucleus, have been prepared for the first time by the condensation of methoxy and ethoxy diaryl-amines with arsenic trichloride. This condensation takes place quite readily as has been observed before with other diarylamines (Burton and Gifson, *J.C.S.*, 1926, 455, 466). Phenyl-*o*-anisidine, phenyl-*o*-phenetidine, phenyl *p*-anisidine and phenyl *p*-phenetidine condense with arsenic-trichloride to yield 10-chloro-4-methoxy-5 : 10-dihydro phenarsazine (IR = OCH_3), 10-chloro-4-ethoxy-5 : 10-dihydro-phenarsazine (IR = OC_2H_5), 10-chloro-2-methoxy-5 : 10-dihydro-phenarsazine (II R = OCH_3) and 10-chloro-2-ethoxy-5 : 10-dihydro-phenarsazine (II R = OCH_3) respectively.



I



II

Phenyl-*o*-phenetidine was prepared by the decarboxylation of *o*-phenetylanthranilic acid. Phenyl-*p*-anisidine (Wieland and Wecker, Ber., *43*, 1910, 708) and phenyl-*p*-phenetidine (Jacofsen, Henrich and Klein, Ber., *26*, 1893, 696) were also obtained from the corresponding anthranilic acids. The methoxy and ethoxy aryl anthranilic acids were prepared by the condensation of *o*-chloro-benzoic acid with suitable amines in presence of copper-bronze and potassium carbonate in amyl alcohol medium.

134. Indigoid vat dyes of the isatin series. Part III.

S. K. GUHA, Patna.

3-indole-2′-(4′-methyl) thionaphthene indigo and its various substituted products have been prepared and their dyeing shades on cotton and on wool compared with those of the corresponding 5′- and 6′-methyl compounds. (Guha and Basu-Mallick, *J. Indian Chem. Soc.*, *11*, 395, 1934; Guha, *ibid.*, *14*, 240, 1937). It has been found that the change in colour due to methyl substitution in 4′, 5′, and 6′-position of the thionapthene nucleus of 3-indole-2′-thionapthene indigo is produced in the same way as was observed by the present author, in the acenaphthenequinone and the aldehyde series (Guha, *J. Indian Chem. Soc.*, *10*, 679, 1933; *13*, 94, 1936; *15*, 20, 1938; *12*, 659, 1935; *14*, 709, 1937, etc.). The effect of methyl groups in the molecule of thioindigo in its 4 : 4′-, 5 : 5′-, and 6 : 6′-position resembles what was found in the above-mentioned two series and also isatin series studied now.

135. Studies in indigoid dyes. Part IV.

S. K. GUHA, Patna.

In this paper various methyl derivatives of 2-thionaphthene-9′-phenanthrene-indigo, having the methyl group in 4, -5, and 6-position of the thionaphthene nucleus of the molecule, were prepared and their properties studied. It was found that the change in the shade of colour due to the Me substitution in 4-, 5-, and 6-position *was produced* in the same way as was observed by the author in the case of dyes belonging to acenaphthene-quinone, isatin and thioindogenide series.

136. Photosensitizing dyes. The influence of anions on the properties of dyes derived from α-picoline.

M. Q. DOJA, Patna.

It was first shown by König (*J.pr.chem.*, *86*, 172, 1912, ii) that when *p*-dimethylaminobenzaldehyde is condensed with quinaldinium and lepidinium salts, with piperidine as a catalyst, dyes similar to cyanines are produced. A similar compound, 2-*p*-dimethylaminostyrylpyridine-methiodide was prepared by Mills and Pope (*J.C.S.*, *121*, 946, 1922), by the interaction of *p*-dimethylaminobenzaldehyde and α-picoline methiodide, which was found to be a powerful sensitizer for green light. In view of the great sensitizing power of this compound, it was thought of interest to investigate the influence of the change of anion on the properties of the compound. With this object in view, the chloride and bromide corresponding to Mills and Pope's compound, have been synthesized and the properties of all the three investigated and compared.

137. Attempts to prepare azine and azonium dyes from isatin.

A. C. SIRCAR *and* A. K. GUHA, Calcutta.

The paper deals with attempts to prepare azine and azonium dyes from substituted isatins. A large number of azines have been described.

But isatin and its substitution products do not form azonium salts evidently due to the mobility of the 'H' atom of the 'NH' group. But when this 'H' atom is fixed by alkylation, the N-alkyl-isatins so obtained readily form azonium salts, but their tinctorial properties are not satisfactory when compared with the corresponding derivatives obtained from phenanthraquinone or acenaphthenequinone.

138. Unsaturation in shellac.

H. K. Sen, M. Venugopalan, *and* S. C. De, Ranchi.

The relative merits of the common methods of determining the iodine values as applied to the study of the degree of unsaturation of shellac have been discussed in a previous communication. For a further study of the mechanics of halogen absorption and its significance on the study of the constitution of shellac, experiments have been conducted with a view to determine how much of halogen really enters into the shellac molecule during the absorption of iodine or iodine monochloride. It has been found that the rate of absorption is different with different halogenating reagents but the chlorine or iodine that is present in the halogenated product is always a small fraction of that absorbed. This points to side reactions like substitution, oxidation, etc. resulting in the formation of halogen acids which will be liberated. The nature of those side reactions are being investigated and the halogenated products actually isolated point to the presence of only one double-bond in the hard lac molecule (α-lac).

139. Wetting agents. Part IV. Further derivatives of arylamine sulphonic acids.

I. S. Uppal *and* K. Venkataraman, Bombay.

The wetting agents described in previous communications were aromatic sulphonic acids characterized by the presence of the -CO-NH-group and a long chain alkyl residue. Extending the reaction further, a series of new surface active substances have been prepared by the condensation of (*a*) oleic acid under suitable conditions with metanilic, aniline 2 : 5-disulphonic, Bronner's, Cleve's, Laurent's, Peri, *a*-naphthylamine-3 : 8-disulphonic, Amido-R, Amido-J and Koch's acids, (*b*) ricinoleic acid with metanilic, Bronner's, Cleve's, Laurent's, Peri and Amido-J acids, (*c*) mixed naphthenic acids of petroleum with sulphanilic and metanilic acids, and (*d*) sulphanilic acid with carproic, caprylic, capric, lauric, myristic, palmitic, stearic, linoleic and abietic acids and with the mixed fatty acids of castor, sesame, cocoanut and linseed oil. Their properties (solubility, stability to acids and alkalies, interfacial tension, Herbig number, protective colloidal action, emulsifying power, and ability to disperse calcium soaps) were then examined by the methods already elaborated (Dhingra. Uppal and Venkataraman, *J. Soc. Dyers Col.*, *53*, 91, 1937; *et sequa*). Comparing the oleyl derivatives of orthanilic, metanilic and sulphanilic acids, the solubility decreased in the order named, but the wetting power increased from meta to para to ortho, while the calcium soap dispersing power was in the reverse order. Increasing the length of the carbon chain from C_6 to C_{18} in N-acyl sulphanilic acids, the solubility in water decreased steadily with the increase in the number of carbon atoms, but the Herbig number which rose continuously up to C_{12} became practically constant when the alkyl chain was lengthened further. This, however, referred only to temperatures above 80°C., as a comparison of the whole series could not be made at lower temperatures on account of the sparing solubility of the higher homologues of the series. The calcium soap dispersing power increased up to C_{12} and then began to fall. Comparing linolenyl-, linoleyl- and oleyl-anilide-*p*-

sodium sulphonates, the known fact regarding the effect of increased unsaturation on improving the solubility and lowering the wetting power was confirmed. The naphthenyl derivatives of orthanilic, metanilic and sulphanilic acids and the products of the condensation of metanilic acid with the mixed fatty acids of coconut and sesame oils were readily soluble substances with good lathering and wetting power.

140. Composition of the fatty acids in the glycerides of *Garcinia Indica* (Kokum butter).

C. J. Dasa Rao *and* N. L. Vidyarthi, Waltair.

The composition of the fatty acids in the glycerides of *Garcinia Indica* (kokum butter) has been determined by the separation of the solid and liquid acids by lead salt alcohol and ether method and the fractional distillation of the methyl esters of the acids. The component fatty acids of the glyceride have the following composition: myristic acid, 1·2%; palmitic acid, 14·7%; stearic acid, 42·6%; oleic acid, 41·3%; and probably linoleic acid, 0·2%.

141. The reactions of ketones with unsaturated hydrocarbons.

M. Omar Farooq, Aligarh.

Industrial Chemistry.

142. Preparation and application of liquid gold.

Atma Ram, M. A. Saboor, *and* Lal C. Verman, Calcutta

Liquid gold is a dark, oily, viscous substance containing resinous compounds of gold and other suitable metals dissolved in essential oils. It is used for the decoration of glass bangles and ceramic wares and is at present imported into India from Germany and England. It is applied to the glass or ceramic articles by means of a feather or brush and after drying is fired carefully in a suitable muffle furnace maintained at about 650°–700°C., when the organic matter burns off bearing a bright film of metallic gold.

Liquid gold has been successfully prepared and on carrying out practical tests, it has been found to be in no way inferior to the best imported product available in India. Methods for the preparation of the different components constituting liquid gold are described. The possibilities of its manufacture in India are also discussed.

143. Setting properties of red lead paints.

N. Ghatak *and* Lal C. Verman, Calcutta.

Red lead paint enjoys a great reputation as an effective rust-inhibitive priming coat for iron and steel structures. But the chief drawback associated with this is the quick settling and the resulting hardening of the pigment, which make it difficult to store the paint for any length of time. In this paper are described the result of attempts to make use of certain dispersing and suspending agents, which will enable the paint to be easily mixed by mere stirring. Stearic, palmitic, oleic acids and their ammonium and aluminium soaps, aluminium resinate and naphthenate, etc. have been tried as dispersing agents and asbestine, silica, and talc have been used as suspending agents. Of these materials, aluminium stearate and talc have given very promising results. It has also been found that double boiled linseed oil accelerates the setting of red lead as compared with raw linseed oil.

144. Studies on some characteristics of Indian coking coals.

R. K. DUTTA ROY, Calcutta.

Considering the rapid scientific utilization of coking coal and its admittedly limited supply in our country, the studies of its characteristics deserve our special attention. This paper embodies the result of the author's investigations on the relation between the caking-index and the proximate analysis, ultimate analysis and the distillation products of the coking coals of India. The effect of the swelling property, decomposition point and the softening point which together play a great role in the formation of cokes as well as in the operation of coke-plant, has also been thoroughly dealt with. From all these facts, it becomes evident that judicious blending of different varieties of coals, is essential to guard against the natural handicap—namely the limited coal-asset of our country.

145. Low temperature carbonization of Indian coals.

S. S. GHOSH, S. K. ROY, *and* B. C. ROY, Calcutta.

Some inferior grades of Indian coals of low volatile and high ash content have been treated under low temperature conditions for making good domestic coke as also for use in producer plants. Useful by-products, such as tar oil, ammonium sulphate, gas, etc., are discussed and a balance sheet has been drawn for running a low-temperature coking plant treating 100 tons of coal per diem with a complete scheme for fractionation of tar oils.

146. Studies into the suitability of some Northern India quartzites for the manufacture of silica bricks.

J. L. SARIN *and* K. K. NIJHAWAN, Lahore.

Silica brick is a refractory material of great importance in the construction of iron smelting furnaces. The industry of iron scrap smelting is rapidly developing in Northern India and the requirements of silica bricks for lining steel smelting furnaces, are at present met by supplies from the only two factories in India located in Raniganj coal fields. The cost of transport from this place to certain parts of the Punjab is very appreciable. With a view to ascertain the possibility of manufacturing these bricks in the Punjab, the present investigation was undertaken. A number of samples of quartzite and other siliceous rocks have been collected from all over the province and examined for their structure in respect of quartzite, tridymite, and crystobalite, before and after firing. Bricks have been prepared on a laboratory scale and further work on the cost of production of silica bricks on a semi-commercial scale is in progress.

147. Characteristics of dry cells made from various Indian pyrolusite ores.

G. D. JOGLEKAR, K. SUBBA RAMAIAH, D. S. NAIDU, *and* LAL C. VERMAN, Calcutta.

Dry cells have been prepared and tested under standardized conditions from a large number of Indian and foreign pyrolusites. From a comparative study of their electrical characteristics it has been shown that many Indian ores compare favourably with the majority of the imported ores as regards their utility in dry cell manufacture.

The experiments also indicate that although very few of the ores can give cells satisfying the B.S. Specification when used in the original state, an admixture with 10 per cent. artificial manganese dioxide causes a considerable improvement in quality. The best of the indigenous ores under these circumstances can give cells which are quite comparable with the better quality cells on the market.

148. Examination and classification of siliceous and felsphathic materials of Indian origin for glass manufacture.

M. A. SABOOR, S. V. ANANTAKRISHNAN, *and* LAL C. VERMAN, Calcutta.

Over 175 samples of raw materials collected from various parts of the country have been examined with a view to determining their suitability in glass manufacture. They have been completely analyzed and, in case of sands, their sieve analyses have also been carried out. On the basis of these analyses, all the materials have been classified. The scheme of classification adopted takes into consideration the silica and iron content of sands, and alumina, iron and alkali content of felspars. By examining the classification mark, it is possible to ascertain whether a particular material is suitable for glass manufacture, and if so, for what particular type of glass it may be used to the best advantage. As a result of this survey, a number of new sources of suitable sands, sandstones, quartz, quartzite, felspar, etc., have been located in different parts of the country.

149. Some problems in tinning of articles of complicated shapes and contours.

H. TRIVEDI *and* LAL C. VERMAN, Calcutta.

Tinning of articles of complicated shapes and contours, such as hurricane lantern, offer difficulties which are not commonly met with in the tinning of sheet stock. The process consists of the following operations: (*a*) degreasing, (*b*) pickling, (*c*) washing, (*d*) fluxing, (*e*) tinning, (*f*) annealing and quenching. At each of these stages certain necessary precautions have to be taken; failure at any stage in carrying out the operation in an adequate manner reflects in the development of characteristic defects in the final product. Technical control required at each of the stages of operation is discussed and the necessity for training a skilled staff of workers is emphasized.

150. Action of ammonia gas on lac.

A. K. THAKUR, Ranchi.

Finely powdered shellac was exposed to ammonia gas for three to four days. The mass so treated was separated into four fractions by lixiviating with water at different temperatures.

Fraction I was obtained by lixiviating with water at a temperature below 5°C. and precipitating the lac by dilute sulphuric acid. The acid value of the sample so separated was 133; Sap. value 310—Yield 2% of total resin. A crystalline acid has been isolated from this fraction, having the probable formula $C_{14}H_{32}O_3$, m.p. 55-56°C.

Fraction II lixiviated with water at a temperature of 10°C. Acid value of separated resin—113, Sap. value—236·7. Yield—5%.

Fraction III lixiviated at temperature 20°C. Acid value—101·4, Sap. value—300. Yield—5·1%.

Fraction IV lixiviated with water at temperatures above 20°C. Acid value—56. Sap. Value–210. Yield—75–80%. This contains 10–15% of ether soluble resin. Its chemical and physical behaviours are alike those of pure lac resin. This process gives a cheaper method of manufacturing hard lac resin than the urea condensation or other extracted process, although the latter processes yield harder resin.

151. Manufacture of garnet lac from by-products of lac.

M. Rangaswami *and* H. K. Sen, Ranchi.

The successful recovery of lac from the by-products obtained in the course of shellac manufacture, chiefly from 'kiri' was observed on a laboratory scale and reported in a previous communication.

With the view of studying the commercial application of the process and its demonstration to industrialists, a semi-large scale Pilot Plant of 30 gallon capacity has been erected which would give an out-turn of about 2 mds. of garnet lac in a working day of 8 hours. Tests made in the laboratory have been repeated in the plant by extracting commercial samples of kiri and the results have been quite successful. Samples of garnet lac which compare very favourably with the commercial garnet lac have been obtained and the estimated cost of production is reasonable and attractive. Further improvements in the process from the point of view of economy and greater out-turn are now under investigation.

Two batches of garnet lac from kiri prepared with the Pilot Plant were analyzed in order to find the properties of the lac and the following results were obtained :—

	Sample No. P2A.	*Sample No. P2B.*
Moisture %	2·63	2·59
Hot alcohol insolubles % ..	0·06	0·10
Wax%	1·04	0·99
Fluidity in secs.	226	251
Life under heat in min. at 150°C.	25	20
Colour index	17·0	19·5

152. Condensation of shellac and shellac acids with alcohols, aldehydes, acids and acid anhydrides.

M. Venugopalan *and* H. K. Sen, Ranchi.

The acids isolated from shellac after the removal of the principal resin acid, viz., aleuritic acid, were themselves used for condensation with natural shellac by heating at 120°C. Condensation took place first, resulting in a shellac-like product but further heating resulted in polymerization.

By condensing shellac acids with suitable proportions of phenol and formaldehyde in presence of alkaline and acid condensing agents, hard, brittle and transparent products could be obtained. The acidity was found to decrease from 184·1 to 75·5 as a result of the change. Employment of shellac itself for condensation will result in the lowering of acid value from 70 to 29. Further treatment of the product like acetylation, treatment with acid anhydrides, etc. will give products from which non-greening varnishes could be prepared specially suitable for the coating of metals.

Shellac and shellac acids could also be condensed with polyhydric alcohols like glycerine and ethylene glycol to give non-drying products which on baking gives satisfactory films. Condensation could also be effected by heating with acid anhydrides like maleic and phthalic anhydrides and combination of the two processes is being tried to get, if possible, products with even better film-forming properties.

153. Manufacture of de-waxed lac.

M. Rangaswami *and* H. K. Sen, Ranchi.

Shellac made by the country process contains wax varying from 2·5 to 5% and though the wax confers a beneficial effect on the lac as applied to certain industries, the demand for wax-free lac or lac with a low wax content for other industries is on the increase at the present time. The partial or complete dewaxing of lac is, therefore, of considerable commercial importance.

Dewaxing of lac can be done by extracting either on alcoholic or an alkaline solution of lac with one of the solvents for wax and recovering the lac by distillation or acid precipitation respectively. Preliminary laboratory trials using petroleum ether or extraction of wax have yielded lacs of wax content of 0·2–0·3% in one case and 0·1–0·15% in the other, the specification for commercial dewaxed lac being a maximum wax content of 0·2%.

Tests are now being made on the possibility of using other and cheaper solvents and also on the study of the suitability of these processes for commercial application.

154. Modifications of the soft resin from shellac.

M. Venugopalan *and* H. K. Sen, Ranchi.

Shellac could be split up into two types of resins—one, a hard resin forming about 70% of the lac and having properties better than the parent lac and the other, a soft resin constituting the remainder. Various methods for the commercial preparation of the hard resin from shellac are being developed, one of which, worked out by the Institute, is by the use of acetone and urea. Appreciable quantities of the soft resin will, therefore, be obtained as a by-product and as this is a soft, sticky substance, the improvement of its qualities by suitable modifications would be of economic importance.

The soft resin left in cold acetone solution, containing about 10% of the hard resin, will give a crisp lac of low melting point after removing the solvent and heating the residue. The hardening could, however, be accelerated and improvement in the properties of the resulting lac obtained by heating the substance with various chemicals.

Heating the soft resin with phosphoric acid before the removal of the residual acetone gives a product whose solution will give air-drying films which are non-corrosive and which have good adhesion and flexibility.

Modification of the soft resin with glycol and further heating of the product with maleic acid will also give a product which could be used for air-drying varnishes. Modification with aniline and formaldehyde is also possible and treatment with phenol and formaldehyde gives a product which will be soluble in tung oil (China wood oil) and which gives films of commendable properties.

155. Modification of shellac with aniline and formaldehyde.

M. Venugopalan *and* H. K. Sen, Ranchi.

Treatment of shellac with aniline and formaldehyde under suitable conditions in presence of an acid catalyst like phthalic anhydride, acetic acid, etc. yields a resin with improved properties.

The characteristic changes brought about by such a condensation are: (1) lower acidity, (2) higher softening and melting points, (3) longer life under heat, and (4) better fluidity.

The possibility of using such a modified lac for purposes of moulding is under investigation.

156. Shellac moulding powders.

S. Ranganathan *and* H. K. Sen, Ranchi.

The plasticity of shellac moulding powders is determined by the degree of polymerization of the shellac and the amount of moisture absorbed by the filler; the latter is considerable in case wood-flour is the filler used. Pre-heating the powder decreases the plasticity while increasing the heat-resistance of the moulded article. The paper gives the relation between moisture content, plasticity and final properties.

157. Separation of lac into sclerolac and soft lac.

M. Sreenivasaya *and* A. Venkatasubban, Bangalore.

At present the separation of lac into the hard and soft lac resins is effected by ether extraction or dilute alkali extraction. We have carried out experiments to achieve the same result by fractional precipitation of lac from alcoholic solution with water. The less acidic constituents of lac are preferentially precipitated, the more acidic ones being soluble in the aqueous alcoholic solution. Acid values of the soluble and insoluble fractions have been determined and the quantitative distribution of the two fractions has been studied at various dilutions of alcohol with water. By this method, lac having an acid value of 81·8 has been separated into two portions of acid value 131·1 and 76·7 in the proportion of 1 : 8 respectively.

158. Utilization of lac dust or molamma.

A. Venkatasubban *and* M. Sreenivasaya, Bangalore.

Molamma or lac dust is one of the usual by-products of the lac industry containing about 65% lac. A process has been described for the economical extraction of Molamma with alcohol with a view to use the alcoholic solution as a cheap grade varnish or for the preparation of garnet lac.

159. Dielectric strength of lacs of known origin.

A. Venkatasubban, M. V. Kesava Rao, *and* M. Sreenivasaya, Bangalore.

The breakdown voltages of lac varnishes prepared from two varieties of seed lac (*Schleichera trijuga* and *Shorea talura*) and the hard lac resins prepared therefrom have been determined. Data have been collected regarding the change in the dielectric strength after baking the films at 90°C. for half an hour and after exposure to an atmosphere of 95% humidity for 48 hours.

160. The use of emulsified organic solvents in textile processing.

M. B. Desai *and* K. Venkataraman, Bombay.

While the use of organic solvents for scouring purposes has long been recognized for wool, it is only in recent practice that they have come to be regarded as useful additions to the kier in the case of cotton, particularly in dealing with material containing excessive waxy and oily impurities. Stable emulsions of various organic solvents (chlorinated aliphatic hydrocarbons, solvent naphtha, tetralin, dekalin, pine oil, etc.) have now been prepared and used in conjunction with caustic soda for the kier boiling of grey cloth, the efficiency of the scouring process being followed by the estimation of the wax content, whiteness, wettability and tensile strength, both after the kier boil and after bleaching and souring. In the absence of caustic soda, the emulsions gave unsatisfactory products, specially with regard to wettability; even when caustic soda was present, the solvent emulsions adversely affected the wettability of the boiled material.

So far as the chlorinated solvents were concerned, the efficiency of the action in the kier resolved itself into the relative speed of the solvent action of the chlorohydrocarbon on the waxes and other extraneous organic matter in the cotton in comparison with its progressive hydrolysis by the aqueous alkali.

The chlorinated solvents, however, were not inferior to the non-chlorinated solvents, but neither proved of real value with reference to the facile removal of wax, which should be regarded as the main advantage that may be expected to accrue from their employment. The whiteness throughout was not markedly outside the limits of experimental error. The claims made for tetralin as a kier boiling auxiliary in view of its ready dispersibility and its tendency to antoxidation could not be confirmed.

The complexity of the factors involved in assaying kier boiling methods renders further experimentation necessary, but the available evidence indicates the caution with which additions to the kier of substances other than the old established and inexpensive detergents must be made.

161. The estimation of salicylanilide in textiles.

R. B. FORSTER, R. C. GANDHI, *and* K. VENKATARAMAN, Bombay.

Salicylanilide is used as an antiseptic for textiles under the name of 'Shirlan', the sodium salt being marketed as Shirlan NA. A minimum concentration of the substance in a given weight of cloth is necessary to ensure complete protection against the growth of mildew, but a satisfactory method of estimation is not available. A procedure based on the coloration of an alcoholic extract with ferric chloride proved inadequate on account of the evanescence of the colour and its sensitivity to conditions such as the *p*H. Salicylanilide in aqueous alkaline solution takes up varying amounts of bromine according to the concentration of the solution, the temperature and the strength of the bromide-bromate mixture, but under specified conditions a tribromo derivative is formed and the reaction can be utilized for the present purpose. The product is the *p*-bromanilide of 3 : 5-dibromosalicylic acid, the orientation of the bromine atoms being determined by fission of the compound with boiling sulphuric acid and isolation of *p*-bromaniline and 3 : 5-dibromosalicylic acid. The sized cloth is extracted with a mixture of dilute hydrochloric acid and chloroform, the chloroform evaporated, and the residue dissolved in caustic soda solution and treated with standard bromide-bromate mixture. On acidification, the excess of bromine is estimated in the usual manner.

162. Hydrogenation of oils by the continuous process.

R. V. JOGLEKAR, V. T. ATHAVALE, *and* S. K. K. JATKAR, Bangalore.

We have tried the activity of nickel formate-kieselguhr catalyst (20% nickel) in a continuous process. The optimum temperature of reduction was 300°, at which the activity of the catalyst was only ¼th of that of the 20% nickel carbonate catalyst. It was not possible to precipitate the formate on kieselguhr as nickel formate is soluble. The catalyst was therefore prepared by impregnating kieselguhr with a solution of nickel formate. The activity of the formate catalyst reduced at 200° and 400° are nearly the same.

163. Cracking of vegetable oils. Part I. Groundnut oil.

N. M. DALAL *and* T. N. MEHTA, Bombay.

Cracking of groundnut oil has been carried out by the non-residuum method of distillation under a pressure of 45, 90 and 135 lbs. per sq. inch and at 12 and 20 atmospheres by the method of Morrell and Egloff (*J. Soc. Chem. Ind.*, 1932, *51*, 133T; *J. Ind. and Eng. Chem.*, 1932, *24*, 1426). The results indicate that the yield of the liquid pressure distillate decreases while the volume of the gas generated increases with the increase in pressure. The specific gravity of the liquid distillate obtained at lower pressure is greater than that obtained at the higher pressure. The percentage yields of motor fuel increases while the percentage yields of Diesel oil decreases with the increase in pressure. The calorific value of the gas obtained at high pressure is greater than that obtained at lower pressures. The analysis of the gas obtained shows that the percentages of CO_2, CO and H_2 decrease and saturated compounds increase with the rise of pressure.

164. Cracking of vegetable oils. Part II. Mowrah oil.

N. M. DALAL *and* T. N. MEHTA, Bombay.

Mowrah oil has also been cracked under various pressures by the non-residuum method of distillation. The results obtained indicate the results as shown in the cracking of groundnut oil.

165. Utilization of Indian vegetable oils. Iodized oils.

S. RANGASWAMI, Waltair.

By employing the iodine chloride method of adding iodine, common edible oils like gingelly and groundnut oils have been iodized. Products containing about 25% of iodine were easily prepared and were found to be very useful therapeutically. Preparations containing about 30% of iodine obtained from some of these were successfully employed in taking X-ray photographs of the lungs. The preparations are found to have good keeping qualities and are considerably cheaper when compared with similar foreign products.

166. Utilization and properties of rice bran and oil derived from it.

KARIMULLAH, N. GHATAK, J. S. AGGARWAL, *and* LAL C. VERMAN, Calcutta.

Development of rancidity in rice bran and rice bran oil on storage has been studied. Solvent-extracted and machine-expressed oil has been examined for its chemical and physical characteristics. The possibility of expressing oil on a commercial scale, its keeping quality and its utilization for edible and other purposes is discussed. Owing to the small percentage of oil that can be expressed from rice bran, it is considered advisable to utilize the bran itself in some such form as biscuits or cakes and make full use of its vitamin content. Experiments in this direction are discussed.

167. Some Northern India essential oils.

J. L. Sarin *and* M. L. Beri, Lahore.

The extraction of essential oils and the preparation of perfumes is an ancient Indian industry which attained in the past a great importance in some parts of Northern India. The industry, is however, gradually dying out. A study of its working method showed that they were very wasteful, the distillation stills were of very old type and the methods of extraction of pure essential oils were unknown. With a view to help the industry in modernizing its methods, a modern type of essential oil still has been locally constructed, and its working has been demonstrated in an important centre of the industry. A number of essential oil bearing raw materials, e.g. citrus fruits (lemon orange), vitivert, rosha grass, fennel, caraway, rose, etc. have been examined and the methods of extracting oil from them on commercial scale have been studied. The physical and chemical constants of the oils produced have been determined. Samples of oil produced have been sent to consumers of the oil all over the country for their opinion about the quality of the oil, etc. Further work is in progress.

168. Physical and chemical properties of water cultrop starch.

J. L. Sarin *and* R. L. Saigal, Lahore.

A method was worked out for the preparation of Water cultrop (sangara) starch (Shafi and Sarin, *Ind. and Eng. Chem.*, *29*, 1436, 1937). The preliminary determination of its physical properties and actual factory tests showed that the starch could be used with advantage for sizing cotton and rayon yarns and for finishing and printing cotton cloth. To evaluate its property as a sizing and finishing material experimental work has now been done on the chemical properties and penetrating and coating power of the starch on cotton yarn. The ratio of α and β amylose in the starch granule has been determined, and compared, with those of well-known starches, e.g. potato, etc., since starches which have approximately the same relative contents of amyloses might be expected to manifest similarities in other properties. Work on the comparison of the relative penetration and coating power of sangara, potato and maize starches is in progress.

169. Constituents of gram germ oil.

J. L. Sarin *and* S. L. Kapur, Lahore.

Like wheat, gram germ also yields an oil the physical constants and chemical properties of which have been studied. The yield of the oil on the weight of the gram is 3·77 per cent. The physical constants of the oil show that it is a drying oil. Work on the determination of the various fatty acid constituents of the oil is in hand.

170. Catalytic polymerization of oils.

M. N. Goswami, Calcutta.

Vegetable oils have been catalytically polymerized to different products from greasing mass to hard resin. It has been seen that the whole glyceride molecule takes part in polymerization. The yield is quantitative. The properties of the products and as well as their industria applications are being studied.

171. Sulphocyanide value of oils.

M. GOSWAMI *and* A. CHOUDHURY, Calcutta.

It is known that Kauffman sulphocyanide value gives half the number in the case of linolic acid. Experiments are being done to show that this is due to formation of conjugated linkages in contact with -SCN.

172. Preparation of a simple form of high vacuum grease.

A. PURUSHOTHAM, Benares.

It has been possible to prepare high vacuum grease which stands moderately high temperatures and what is more which can stand the action of such corrosive gases like bromine, iodine, chlorine, nitrogen proxide, and hydrochloric acid. In this last respect it is distinctly better than almost any variant of the ordinary rubber grease. Furthermore its working is free from the well known difficulties due to clogging, etc. to which the metaphosphoric acid is subject. It is prepared from highly pulverized carbon and fluxed with a very small quantity of castor oil. The substitution of theobroma in place of castor oil gave better results. It can be washed off with chloroform.

Biochemistry

173. Nutrition studies in Bihar. Part II. Chemical composition of some of the local edibles.

K. MITRA, Patna.

Forty items of foodstuff purchased from Patna market were chemically analyzed for moisture, protein, fat, carbohydrates, crude fibres, calcium, phosphorous and iron content. The calorific value per hundred grammes of each of the edibles were also calculated. Out of the four samples of local rice analyzed, the parboiled variety was found to be comparatively richer in mineral elements than the raw milled ones, and the figures were almost equivalent to those of *Laoa* or puffed paddy. Rice and wheat brans used exclusively as cattle fodder, yielded on analysis high figures for proteins, fats and minerals. Suggestion for utilizing the brans in place of refined cereal in the vegetarian diet have also been made. The calcium content of leafy vegetables was found to vary from 0·086 to 0·310%. The various sattoos were found to contain fairly high percentage of nitrogen and minerals. Gurh was found to contain high percentage of calcium (0·400%), presumably due to the retention of lime, used for the purposes of clarification during the processes of manufacture. The three species of fish analyzed showed a protein content of 17 to 18 per cent.

174. Cataphoretic velocity and surface condition of polymorphonuclear leucocytes from rabbits suspended in different media.

S. N. MUKHERJEE, Calcutta.

Polymorphonuclear leucocytes were obtained from rabbits by Hamburger's technique and suspended in different media, viz., normal saline, M/15 phosphate buffer (pH, 7·4), isotonic glucose and isotonic buffered glucose (pH, 7·4) both in presence and absence of traces of serum. Cataphoretic speeds were then determined in these media and the behaviour of these leucocytes in the interface between the suspending media and a few organic liquids, both of low and high surface tensions (viz., cyclohexane, cyclohexanol, olive oil, cedar oil, etc.), was studied following Mudd's technique. It was observed that M/15 phosphate buffer and isotonic buffered glucose offered the two best media for such studies, specially in presence of traces of serum.

175. Effect of addition of calcium on the biological value of the proteins of Indian diets.

V. Ranganathan *and* Y. V. S. Rau, Bangalore.

During our investigation on the biological value of the proteins of a few typical Indian diets, it was observed that the Madras diet at 10·75% protein had a biological value of about 40, though rice with a biological value of about 83 formed a major part of the diet. At the suggestion of Dr. W. R. Aykroyd, Director, Nutrition Research Laboratories, Coonoor, experiments were conducted with addition of calcium in the form of $CaCO_3$.

It was found that in the case of Punjab and Bombay (Parsee) diets, there is some increase in the biological values on the addition of calcium, but it is more significant with the Madras diet, though all the diets contain enough calcium according to Sherman's standard for an adequate diet. This might be due to the non-availability of calcium in the Madras diet. Further work to confirm the above observations is in progress.

176. Biological value of the proteins of a few typical Indian diet.

Y. V. S. Rau *and* V. Ranganathan, Bangalore.

The object of the present work has been to investigate the biological value of the proteins present in the mixed food by the nitrogen balance sheet method. Foods characteristic of various parts of India have been obtained from different messes of the Indian Institute of Science Hostel. For example, Madras, Punjab and Bombay (Parsee) foods have been investigated.

Parsee diet had the highest biological values, digestibility and net protein value and Madras diet the least (40·68) even though rice with a biological value of about 83 forms a major part of the Madras diet.

177. The availability of calcium and phosphorus in a few typical Indian diets.

V. Ranganathan, Bangalore.

It has been observed that the biological value of the proteins of the Madras diet increased on the addition of calcium and it was suggested that the calcium in the Madras diet may not be available (*Nature*, July 1938, p. 165). Experiments were conducted to determine the availability of calcium and phosphorus in the diets by using the procedure adopted by S. K. Kon and others (Milk Nutrition Committee Report, 1938, p. 9).

It was observed that the Madras diet whose biological value of proteins increased with the addition of calcium, has got the lowest figures for the availability of calcium and phosphorus. The factors that are responsible for the low availability of calcium and phosphorus are under investigation.

178. Vitamin A and C changes in the mangoes during ripening.

G. B. Ramasarma *and* B. N. Banerjee, Bangalore.

Continuing the previous work (Banerjee and Ramasarma, 1938, *Agric. and Livestock in India*, 8, 253) the changes in the Vitamin A and C content taking place in the mangoes during the ripening process after plucking the mature ones from the tree, have been studied. The results obtained show a high variation in the Vitamin C content even in the mangoes from the same tree. There was no significant rise or fall in the Vitamin C content of either the pulp or the skin of the mango during the ripening of the mature mangoes and during the storage of fully ripe fruit at 0°C. for about two weeks. There was a steady rise in the carotene content of the mango during the ripening process; the xanthophyll content was all through very low. The Vitamin C content of the skin was nearly double that of the pulp.

179. Pectic change and organic acids in fruits. Part I.

P. Neogi *and* K. L. Mandal, Calcutta.

The percentage of organic acids as well as pectin and pectous substance in Indian fruits is being estimated and preliminary examination has given interesting results.

180. Sugar-acid-pectin relationship in the stabilization of fruit juices.

N. N. Chopra, Lahore.

The conditions under which the tissues occupy the top, middle or bottom position in a sample of fruit juice have been investigated. It has been found that the concentration of sugar and pectic substances determine the settling of the fruit cells and tissues provided the acid concentration is at an optimum value.

The present paper deals with this relationship.

181. Enzymes in snake venom.

B. N. Ghosh *and* D. K. Chowdhury, Calcutta.

The critical inactivation temperature of the proteolytic enzymes in the venoms of Cobra (Naja Naja), banded Krait (B. Fasciatas), Echis Carinata and Vipera Russelli has been found to be 55°C., 53°C., 55°C. and 62°C. respectively. The critical inactivation temperature of trypsin mixed with the proteins of heated cobra venom is 60°C. It has therefore been suggested that the proteolytic enzyme in snake venoms is identical with trypsin. The small variations found in the critical inactivation temperature is to be attributed to the different types of proteins with which the enzyme is associated in the different venoms.

It has also been observed that solutions of venoms of Krait and Echis Carinata whether previously heated or not can activate trypsin and that solution of cobra venom produces similar effect only when heated at 70°C. for one hour or so. Russell viper venoms whether heated or not always produces inactivation of trypsin.

182. Intermediate compounds in the biological oxidation of ammonia by nitrifying organisms.

W. V. B. Sundara Rao, P. V. Krishnamurty, *and* G. Gopalarao, Waltair.

It is well known that ammonia is oxidized to nitrite by nitrosomonas occurring in the soil. During an exhaustive investigation of the physico-chemical mechanism of this oxidation, attempts have been made to detect the presence of hydroxylamine and hyponitrous acid, the two possible intermediate products. Hydroxylamine could in no case be detected, while tests for hyponitrite were always obtained. A large number of nitrifying cultures were examined, the cultures being prepared from soils of different parts of India.

183. The disintegration of tobacco mosaic virus preparations with sodium dodecyl sulphate.

M. Sreenivasaya, Bangalore *and* N. W. Pirie, Cambridge.

The kinetics of the disintegration of the liquid crystalline preparation of tobacco mosaic virus by sodium dodecyl sulphate, has been studied. The preparation and properties of the resulting unstable protein are described.

184. Morphology and physiology of indigenous yeasts.

N. N. Chopra, Lahore.

Eighty samples of fruits collected from various localities have been investigated and 200 cultures have been made. It has been found that some wild yeasts isolated from these differ morphologically from the known strains. Some of these yeasts have been isolated from regions where high temperature conditions (ca 40°C.) have been prevailing. It is intended to examine whether the employment of any of these strains would result in an improved fermentation.

185. Chemotherapy of bacterial infections.

K. Ganapathi, Bangalore.

In view of the recent discovery of the specific effect of sulfanilamide and its derivatives in many bacterial infections, a series of derivatives of the general formula $CH_2 : CH.CH_2.NH.CS.NH.C_6H_4.SO_2.R$ have been synthesized. The gold salts of such compounds are tried in tuberculosis. Such compounds where R contains acid groupings are expected to be of value against the infections due to *cocci* group of bacteria.

186. Oxidation-reduction potentials of *Vibrio Choleræ* and related organisms.

B. N. Mitra, Calcutta.

The electrode potentials of vibrio cultures in one per cent. peptone water buffered with a phosphate at *p*H 7·6 to *p*H 7·8 were observed with a view to their classification. The average potential curves of the vibrio strains of different chemical groups are different, and are consistent with the fact that the vibrios of different chemical groups have different metabolic activities. Organisms containing protein I have usually higher potentials than those having protein II.

The electrode potentials of vibrio cultures fall down to a minimum in about six hours and then gradually rise, reaching the maximum in about thirty hours. The fall in potentials corresponds to the lag phase of the growth of the organisms, and is characterized by having a low *p*H in the medium. The *p*H rises along with the increase in potentials.

187. Study of pectin content of bagasse.

K. G. Mathur, Lahore.

Methods for the extraction of pectin from bagasse have been described and results showing occurrence of pectin to an extent of 10% in freshly crushed bagasse are given.

Analytical Chemistry

188. A rapid and simultaneous method of determining nitrogen and sulphur in coal.

K. L. Roy, Calcutta.

Not more than 0·5 g. of 60 mesh powdered coal was taken in a nickel crucible and fused with approximately 1·5 to 2 g. of metallic sodium. The fused mass was then lixiviated with water and the alkaline filtrate which contained cyanide and sulphide of sodium was treated with 10% cadium acetate solution when CdS was precipitated. Fifty per cent. acetic acid was then added and the liquid heated to boiling. The distillate was allowed to bubble through a known volume of standard $AgNO_3$ solution, when HCN was precipitated as AgCN. In this way introgen and sulphur in coal were fixed as insoluble CdS and AgCN. The precipitated CdS was estimated iodometrically and the excess of $AgNO_3$ solution was titrated with standard KCNS solution.

189. A note on some modifications of Pregl's method for the micro-analytical determinations of carbon and hydrogen in the humid atmosphere of tropical summer.

M. C. Nath, Dacca.

Pregl's method for the micro-analytical determinations of carbon and hydrogen of an organic substance could not give satisfactory results in the humid atmosphere of summer in India, a lower percentage of carbon being always obtained. The following modifications were therefore found essential. The period of actual combustion was raised from 10 to 15 minutes. The rate at which the air (also oxygen) was drawn was increased from 3-4 c.c. per min. to 4-5 c.c. per min., in order to remove the extra-pressure generated inside the combustion train. Some important precautions were also adopted with regard to the setting of the connecting tubes, the frequent alteration of connecting tubes that are more liable to be damaged and, last though not the least, the constancy of the humidity of the balance room where the ultimate weighing is done.

190. A fine adjustment device for use with the micro-Dumas' apparatus.

S. Rangaswami, Waltair.

A very simple and cheap device for delicate manipulation of the stop-cock with long handle in Pregl's micro-Dumas' apparatus has been evolved. The use of this is considerably helpful even to the expert micro-analyst and at the same time makes the determination safe even at the hands of the beginner.

191. Micro-determination of the kinetics of tyrosine-tyrosinase action.

M. Sreenivasaya, Bangalore *and* K. Linderstrøm-Lang, Copenhagen.

A micro method for determining the oxygen uptake accompanying tyrosine-tyrosinase reaction, in quantities of the reaction mixture of the order of a tenth of a cubic millimetre. This method facilitates a determination of the enzyme concentration in single cells.

192. Estimation of members of naphtol AS series.

T. N. Mehta *and* V. B. Thosar, Bombay.

With the increasing importance of members of naphtol AS series in dyeing and printing it becomes necessary to evolve out a rapid method for estimating the quantity of naphtol either in a substance or in a bath. The titrations of the solutions of members of naphtol AS series with diazo-solutions present many difficulties. With increase in the bulk of the molecule they are very difficultly soluble in caustic soda solution, and hence the amount of caustic soda to keep them in solution is nearly five times the theoretical amount, which, in its turn, seems to be detrimental for obtaining the correct end point. The solutions obtained are colloidal in nature and are susceptible to being salted out during coupling, thus making quantitative coupling impossible. Further, since the resulting azo-compounds are insoluble, inaccurate results are liable to be obtained by the occlusion of the uncombined naphtol in the grains of precipitated azo-compound. A new method has been devised to overcome these difficulties, making use of pyridine alcohol mixtures in varying proportions and from the experiments carried out the method seems to give good results which are correct within $\pm 0{\cdot}5$ per cent.

193. A new method for estimating hydrogen by absorption in technical gas analysis.

H. N. Banerjea, L. A. Bhatt, *and* R. B. Forster, Bombay.

Numerous methods have been proposed for the estimation of hydrogen in mixtures of hydrogen, saturated hydrocarbons and nitrogen by absorption. None of those methods, however, has been found suitable for the estimation of hydrogen in coal gas analysis.

A simple and effective method has been evolved for this purpose whereby the hydrogen in the residual gas is absorbed rapidly and completely by means of an absorption medium consisting of an aqueous suspension of dinitrosoresorcinol in the presence of a freshly reduced nickel catalyst supported on kieselguhr. Contrary to the experience of other workers, it has been found that basic nickel carbonate when reduced at a dull red heat (650–700°C.) proved to be an active catalyst. The estimation was carried out at ordinary temperature in a Lunge-Orsat apparatus provided with a fifth absorption pipette. The catalyst was not poisoned by traces of carbon monoxide.

194. Estimation of gold in cyanide solutions.

B. Shah *and* K. R. Krishnaswami, Bangalore.

The usual methods for control assays of cyanide solutions are as laborious as the assay methods for gold bearing rock.

We have investigated six of the well-known methods and found the method of Moldenhauer satisfactory. Moldenhauer's method had however to be modified in order to secure satisfactory results in presence of copper and silver especially. The details of the results obtained has been presented in the paper.

195. Estimation of calcium in different varieties of rice by two methods.

V. V. S. Murthy *and* Y. V. S. Rau, Bangalore.

The calcium content of different varieties of rice was estimated by (1) usual permanganate (N/100) method, (2) the micro-method of Rapport and Rapport using ceric sulphate with suitable modifications.

The latter method was found to give better results.

196. Elimination of titanium from a mixture of the oxides of titanium, niobium and tantalum.

S. Gopala Rao *and* K. R. Krishnaswami, Bangalore.

A systematic fractional crystallization of the double oxalates prepared from the mixed oxides have been carried out, and the various crops for niobium, tantalum and titanium have been analyzed. The data regarding the solubility of the double oxalates and the distribution of niobium, tantalum and titanium in the various crops are tabulated in the paper. A method for elimination of titanium from such mixtures is also described in detail.

197. Estimation of zinc in presence of copper, silver and mercury by means of quinaldinic acid.

P. R. Rây, N. K. Dutt, *and* T. C. Sarkar, Calcutta.

It was previously reported that zinc can be very satisfactorily estimated as zinc quinaldinate in presence of manganese, magnesium, calcium, strontium, barium, iron, aluminium, titanium, beryllium, uranium, arsenic and phosphoric acids under suitable conditions. It has now become possible to estimate it by the same reagent in presence of copper, silver and mercury using thiourea as a masking agent for the latter metals with which it forms quite stable complex cations. The results are highly satisfactory.

The method has also been developed for the micro-determination of the element.

Miscellaneous

198. Dioxane as a cryoscopic solvent for shellac.

G. N. Bhattacharya *and* H. K. Sen, Ranchi.

Dioxane 1 : 4 has been used as a solvent for shellac for its molecular weight determination by the cryoscopic method, as the usual Rast's method using camphor is open to the objection that at the high temperature employed a part of the resin may undergo polymerization and the value actually obtained may not represent the true molecular weight of the original sample. Dioxane has been used in preference to other solvents since it has a high boiling point and is a neutral solvent and, therefore, it has less chance of chemical interaction with the lac resin in solution. Purification of this solvent was carried out according to the method of Eigenberger and only the middle fraction of the final distillate was employed. The molar depression of freezing point, K, was found to be 4950 using naphthalene and phenanthrene. But in working with this solvent, it has been observed that the freezing point of both the solvent and the solution changes with time on standing in the Beckmann tube owing probably to absorption of moisture from air inside the tube or more possibly to the slow but gradual process of dissociation of dioxane molecules to acetaldehyde molecules. All the determinations were therefore, made as quickly as possible. Lac first forms into a flocculent mass in dioxane at a temperature near about its freezing point but forms a clear solution in about half-an-hour on standing or in about 20 minutes on stirring. At about ordinary room temperature shellac goes into clear solution in about 12 to 15 minutes.

199. New local anæsthetics. Part IV.

K. N. Gaind *and* J. N. Ray, Lahore.

From the consideration that percaine has no ester or benzoyloxy grouping and yet it is a potent anæsthetic, it was deemed of interest to synthesize substances of the structure (*p*) or (*m*)

$$R_1.C_6H_4.NH.COR_2N(R_3)_2.(R_1 = H, \text{ or } COOEt \text{ or } COOMe); \quad R_2 = (CH_2)_n; R_3 = Et, \text{ etc.}$$

The local anæsthetic efficiency has been tested by the rabbits cornea method. It has been found that the meta series is one and a half times more active than the para series. The activity of compounds $n = 2$ is less than those of compounds having $n = 1$.

200. A study of Kolhapur waters from different sources.

J. I. Airan *and* S. V. Shah, Kohlapur.

Samples of water from a dozen sources have been examined; out of these the water from nine sources has been examined regularly every month. From the data for one year (July, 1937 to June, 1938) conclusions have been arrived at that water from deep tube wells is as good as any other water which has undergone systematic purification, and that in a tube well situated on a low-lying site, the water is likely to be contaminated.

SECTION OF GEOLOGY

President :—S. K. Roy, M.A., Ph.D., F.G.S.

Economic Geology

1. Sub-artesian effect at Yedrami, Andola Taluq of Gulberga District.

C. Mahadevan, Hyderabad, (Deccan).

During the excavation of a well by H.E.H. The Nizam's Well Sinking Department at Yedrami (Lat. 17° 48′ 15″: Long. 76° 32′) some sub-artesian springs with a head up to about 10 ft., with a discharge of 80,000 gls. per hour, were encountered. Yedrami is situated near the escarpment of a Deccan Trap plateau. The Deccan Traps which attain in the area a maximum thickness of about 100 ft., overlie purple shales of the Upper Bhima Series. The physiographic conditions and geological causes that contribute to the occurrence of sub-artesian springs are discussed in the paper. The importance of the find in an arid region like the Gulberga District in relation to the development of minor irrigation schemes is incidentally brought out.

2. Some Punjab clays.

J. L. Sarin *and* K. K. Nijhawan, Lahore.

Until recently the Punjab pottery industry had to depend for its white burning clays on supplies from Delhi province. The first systematic survey was carried out in the year 1933 and a report published (J. L. Sarin 'Some Punjab Clays', Indian Ceramic Journal, May 1933 and 'The Pottery Industry in the Punjab, 1933'). As a result of this survey, white burning clays, and other pottery raw materials were located and one of them, the Ratucha clay has since been commercially developed. Most of these clays were found in the Salt Range under the limestone bed. Further search in this range has shown that good white burning clays are found in a number of localities mostly under the limestone bed. In certain localities, specially Mari Indus, in the trans-section of the range, the outcrop of a few clay deposits is visible on the surface, while in some cases boring is necessary. The physical and chemical properties of various samples of clays, are under examination, with a view to ascertain their nature and the possible uses to which they can be put in the ceramic industry.

3. Red ochre deposits in the Punjab.

J. L. Sarin *and* K. K. Nijhawan, Lahore.

Ochre is an important pigment used in paints, varnishes, linoleum and oil-cloth manufacturing industries. Recently, the paints and varnish industries have developed considerably in Northern India, but for their supplies of ochre (red and yellow) they have to depend upon foreign sources. Accordingly, a search for these pigments was made in the province, and a number of samples collected from the Salt Range, Suleiman range and the Himalayas (Kangra valley and Simla hills). They have been examined and evaluated as pigments. It has been found that some of them come up to the standard specifications (British and Indian) laid out for such pigments, while in case of others some further work is necessary for obtaining the correct shade of colour. This work is in progress. It is also proposed to survey the extent of the deposits.

4. Geology of the chromite deposit of Jojohatu, Singhbhum.

B. S. Bhadauria, Dhanbad.

The paper gives the summary of the author's work undertaken under the guidance of Prof. S. K. Roy and Mr. N. L. Sharma. The main rocks of this area are quartzite, slate, slaty shale, pyroxenite, saxonite, dunite, serpentine, talc schist, chert, granite and laterite. Serpentinization of the ultra-basic rocks has been regarded as an autometamorphic process. The chromite of this area has been classified into four types of ore—Boulder ore, Reef ore, Yellow ore and Lateritic ore. A description of the methods of mining and concentrating the ores, as practised at Jojohatu, is given. The chromite mineral seems to have crystallized from the magma after the crystallization of olivine and enstatite, and its concentration was mostly brought about during the process of serpentinization.

Minerology and Petrology

5. Miscibility amongst the various feldspar members as revealed by a study of the feldspars from the mica-pegmatites of Nellore.

N. Jayaraman, Bangalore.

Details of chemical and mineralogical investigation of the various types of feldspars, including perthites and microperthites, from the mica-pegmatites of Nellore are given and their mutual relations are discussed.

A quantitative study of these feldspars shows definitely that mutual solubility exists between the potash and the soda members on the one hand and the soda member and anorthite on the other, whereas the potash member and anorthite are not miscible. It is deduced that the *Ab* member which is in solid solution with the *Or* mixed-crystal is responsible for the small amount of *An* found in the *Or* mixed-crystal, because, the ratio of *Ab* to *An* is almost the same in the *Ab* as well as in the *Or* mixed-crystal. This indicates that the *Or* member is free from *An*. Further, it is also noticed that the soda member is more soluble in the potash member than the potash member is in the soda member.

6. Royite, a new mineral, from the Jharia coal-field.

N. L. Sharma, Dhanbad.

The mineral is chocolate-brown to black in colour. It occurs in shining blades along the joint planes of Barakar sandstones and shales, associated in some cases with ordinary quartz. It has been discovered at several localities in the Jharia Coal-field. In hardness, specific gravity, refractive index and birefringence, the mineral resembles quartz; but its longitudinal sections show one distinct cleavage and lamellar structure, and its cross-sections are not truly hexagonal and they show three sets of cleavages. The mineral is optically pseudo-uniaxial positive. Chemically, it is mostly a silicate of iron and magnesium. The paper describes the physical and optical properties of the mineral.

7. On fibrous quartz from the Bababudan Hills, Mysore State.

C. S. Pichamuthu, Bangalore.

Quartz has been considered as a mineral to which the fibrous habit is abnormal. Only a few cases of fibrous quartz have so far been reported, and so the occurrence in the Bababudan Hills, of quartz with a fibrous habit, is considered worth description. The mineral is pseudomorphous after fibrous amphiboles, such as actinolite and bababudanite. The paper gives a description of the mineral and discusses the mode of origin of the fibrous habit.

Photographs of hand specimens and micro-photographs of thin sections illustrate the paper.

8. Cordierites from Mysore.

M. R. SRINIVASA RAO, Bangalore.

This paper contains a study of cordierites from different parts of Mysore. The mineral in each case has been studied from the point of view of occurrence, alteration, inclusions and pleochroic haloes. Attention has been drawn to some unusual features noticed in micro-sections. These cordierites have also been compared with those described from other parts of India. The important characters described in the paper are illustrated with micro-photographs.

9. On the petrology of the felsite of Galipuje, Mysore State.

C. S. PICHAMUTHU, Bangalore.

An area of approximately six square miles to the east of the Bababudan Ranges is occupied by a dark fine-grained and porphyritic acid rock. A mention of the occurrence of this rock was made by Sampat Itengar in 1907, and no attention has since then been paid to this occurrence. The present paper gives a complete account of the petrographic and chemical characteristics of the rock. As a result of this study, the rock is identified as a quartz keratophyre.

The paper is illustrated with micro-photographs.

10. Study of Panjal Traps in the neighbourhood of Srinagar, Kashmir.

RAJ NATH *and* P. N. GANJOO, Benares.

The occurrence of acid rocks in the Panjal Traps of Kashmir was for the first time pointed out by the late Prof. K. K. Mathur (*Current Science*, October, 1933, p. 126). This was, however, questioned by some and thought quantitatively unimportant by others.

With a view to making a detailed study of the Panjal Traps, the present authors visited a number of localities in Kashmir, mainly in the vicinity of Srinagar, in the month of June 1937. Petrographic and chemical description of the rocks collected in this tour is given in this paper. The Panjal Trap Rocks, as a result of this investigation, fall into two distinct groups:—

(1) The Acid Rocks, and
(2) The Andesitic Rocks.

The Panjal volcanic activity was not totally of a basic phase but Acid Volcanic Rocks were also erupted and are not quantitatively so unimportant as hitherto supposed to be.

11. The occurrence of acid rocks in the Deccan Trap of the north of Salsette Island, Bombay.

A. S. KALAPESI *and* H. S. DALAL, Bombay.

The occurrence of Acid Rocks in the Salsette Island, have been previously described by Dr. C. S. Fox and Dr. M. S. Krishnan, late Prof. K. K. Mathur, and by other workers.

In this paper the authors record a few more areas of acid rocks in the northern part of the Salsette Island, and they are as follows:—

Rock Type.	*Area.*
(1) Augite-Granophyre.	Kandivili.
(2) Altered Granophyre.	Malad.
(3) Trachyte.	Mandepeshver.

(1) *Augite-Granophyre*:—In the Kandivili hill the outcrop lies about one mile east of the Kandivili Railway Station. The hill runs approximately north-south direction. It forms a steep escarpment on the eastern side about 200 feet high and occurs as a detached mass in the Deccan Trap of the area.

(2) *Altered Granophyre*:—The exposure of this acid rock lies on the east side of the Malad Railway Station, known locally as the Malad hill. The hill is a continuation of the portion of the Kandivili hill. It overlies felsite which dips 10°–12° west. The rock is much altered under the tropical climate. Beautiful columnar structure is seen where the rock is not weathered.

(3) *Trachyte*:—This rock occurs in detached outcrops in the village of Mandepeshver on the western side of the Borivili Railway Station, and extends about one and a half miles in length parallel with the Kandivili and the Malad hills. In the field the rock appears more or less horizontal. These detached outcrops are from one foot to several yards in height. At Eksar (south of Mandepeshver) it appears in dome like masses, sometimes a dome is fissured or severed into two parts. The rock is traversed by innumerable fine veins of silica and calcite, which could be seen in a hand-specimen.

These rocks are compact and fine grained, and are composed essentially of quartz and felspar with occasional phynocrysts either of felspar or of plagioclase. Phynocrysts of pyroxene of the Aegerine-augite variety are also present.

A chemical analysis of Augite-granophyre gave the following result:—

$SiO_2 = 68{\cdot}49$: $TiO_2 = 0{\cdot}36$: $Al_2O_3 = 12{\cdot}96$: $Fe_2O_3 = 3{\cdot}01$: $FeO = 2{\cdot}60$: $MgO = 0{\cdot}82$: $CaO = 2{\cdot}97$: $Na_2O = 4{\cdot}83$: $K_2O = 3{\cdot}52$: $H_2O+ = 0{\cdot}36$: $H_2O- \cdot 0{\cdot}41$: $P_2O_5 = 0{\cdot}38$: $MnO = 0{\cdot}04$: Total $= 100{\cdot}75$. Sp. Gr. $= 2{\cdot}69$.

12. On the origin of the charnockites.

N. Jayaraman, Bangalore.

A detailed study of the acicular inclusions of rutile in the Pallavaram charnockite quartz confirms the suggestion of Holland that 'deformation' in the charnockite occurred when the magma was still in a plastic condition and just before complete consolidation, resulting in production of granitic structure. The origin of the acicular inclusions in the charnockite quartz can be ascribed to a general infiltration of titanium solution during the final stages of consolidation of the original magma.

It can be gathered from the mode of origin of the acicular inclusions that the charnockites are only of magmatic origin suffering a slight metamorphism during the later stages of consolidation of the magma, the metamorphic forces acting just before the crystallization of the acicular rutile inclusions. Thus the charnockites appear to be only slightly metamorphosed crystalline intrusives in the peninsular gneiss.

13. Some sedimentary structures in the Manglur Band of Dharwars.

C. Mahadevan, Hyderabad (Deccan).

The Manglur Band of Dharwars forms a narrow run of the schistose series in Shorapur taluq of Gulberga District, Hyderabad State, and consists of hornblende and chlorite schists, granodiorites, siliceous schists, and Champion Gneisses. Auriferous quartz veins run parallel to the strike of the schists and tourmaline-bearing pegmatite veins and reefs cut them, often obliquely. The schistose series extends for about 16 miles along strike (5°N—20°W) with a westerly dip at high angles. The average width of the band is about 3 miles.

Interleaved amidst the hornblende-schists and granodiorites, are well defined runs of schisted quartzites, cherty schists, limestone bands, and phyllitic layers. Evidence of ripple marks, conglomerates and laminations, which are frequent along certain well-defined lines clearly indicate an original sedimentary origin for them. The paper describes the results of the field study of the rocks of the Manglur Band with special reference to the sedimentary structures occurring in them.

14. Tremolite marbles from Singareni, Warangal District (Hyderabad).

N. Jayaraman, Bangalore.

Samples of marble from the Singareni area were examined before and after separating most of the included tremolite crystals. A detailed study of the tremolite crystals was also carried out and it was found that it had the normal composition.

Most of the marble samples analysed were found to be more or less dolomitic in composition. It was also noticed that their composition was very variable and further that their tremolite content varied with depth. Further work is in progress.

Stratigraphy and Palæontology

15. A few observations on the stratigraphical sequence of some of the Purana sedimentaries, North Krishna Basin, Nalgonda District, Hyderabad State.

S. K. Mukherjee *and* L. S. Krishnamurthy, Hyderabad (Deccan).

Along the north bank of the Krishna in the Nalgonda District, Hyderabad State, a long but narrow band of Purana sedimentaries occurs as a continuation of the beds south of the river where they are extensively developed. A report on this area by late Mr. W. King is embodied in his classical Memoir, Vol. VIII, Geological Survey of India.

The sedimentaries mainly consist of a lower series of gritty conglomerates, quartzitic sandstones, shales and slates, and an upper series of limestones. Though the limestones constitute a major portion of formations in the type area, they occur only as a narrow band fringing the north bank of the Krishna within the State where the beds are mostly represented by the lower series of shales and quartzites.

King correlates the limestone with the lowermost Kurnools, *i.e.* Narjee beds, and the shales, sandstones and the quartzites, with the topmost Cuddapahs, *i.e.* the Sreesailem quartzite beds, thus indicating a considerable time lag and a widespread unconformity between the two formations.

Recent revision survey of this area reveals field relations tending to show a regular sequence in deposition of the lower and upper series without any widespread stratigraphical break, although local faulting and minor disturbances have frequently affected the beds.

The paper discusses their stratigraphical relations and suggests a conformable continuity in deposition relegating both the local upper and the lower series to the lowermost Kurnools.

16. The age of some metamorphosed sedimentary rocks in parts of Warangal District, Hyderabad State.

SYED KAZIM *and* C. MAHADEVAN, Hyderabad (Deccan).

A band of metamorphosed sedimentary rocks consisting of quartzites, slates, and marbles run amidst garnetiferous gneisses in parts of Khammemet and Yellandu taluqs of Warangal District, in Hyderabad State. Bruce Foote and King who made a rapid survey of the area in the seventies of the last century, relegated them to the Purana Group (Cuddapah and Kurnool formations). An examination of the area recently by the authors in the light of the classification of rocks made by Jones, Dunn, Krishnan and others of the G.S.I. in Orissa, Bihar and Central Provinces, brings out that this group of metamorphosed rocks met with in the Warangal area are really members of the 'Newer Dharwars' of Jones.

17. Rhynchonellids from the Cretaceous Series of South India.

G. W. CHIPLONKER, Benares.

In pursuance of the study of the rhynchonellids from the Bagh Beds, a similar detailed study of the rhynchonellids from the Cretaceous series of South India has brought forward evidence having a very important bearing on the faunal connection between the Narbada valley and the Trichinopoly District, which was believed by P. N. Bose to exist during the Cretaceous period. These rhynchonellids from South India are characterized by a multicastate transverse shell with the growth lines tending to be strongly tegulate; the ventral valve is very shallow with a sub-erect to slightly incurved beak; ventral sinus is more marked than the dorsal fold; foramen is sub-elliptical, hypothyrid; deltidial plates are disjuct to conjunct (though never strongly so); dental plates are divergent and strong; dorsal median septum is fairly stout; dorsal muscle area is quadrate to sub-circular in outline, with the anterior scars individually pear-shaped. These rhynchonellids belong to the southern stock represented by *Tegulorhynchia* of Chapman and Crespin. Their ancestry is traceable to *Kallirhynchiid* stock, though they do not appear to have descended directly along the line of *Malwirhynchia* Chiplonker, from the Bagh Beds. Thus the present study of these rhynchonellids shows that the Narbada valley and the Trichinopoly Districts were not in direct faunal communication, a conclusion which was also arrived at from the author's study of the echinoids from the Bagh Beds. This result has an important bearing also on the question of the relative ages of these faunas.

18. On some limestones from the cretaceous rocks near Pondicherry.

L. RAMA RAO, Bangalore.

In a paper communicated to this section of the Congress in 1932, the author gave a brief account of an interesting type of limestone from the Pondicherry Cretaceous area, and pointed out its importance in revealing the presence of algæ like those he had just discovered in the Trichinopoly Cretaceous area. Several other limestones from the Pondicherry Cretaceous have now been examined and these have been described in the present paper. All of them are seen to contain algæ, and on the evidence of these and other fossils, an attempt has been made to correlate these doubtful rocks of the Pondicherry area with the much better known Cretaceous rocks of the Trichinopoly District.

SECTION OF GEOGRAPHY AND GEODESY

President :—N. SUBRAHMANYAM, M.A., L.T., F.R.G.S.

1. Markets of Calcutta.

A. K. BANNERJEE, Calcutta.

Markets are the nerve centres of a city like Calcutta. The results of a geographical study of the principal markets of Calcutta have been embodied in this paper.

2. Geography of Puri and adjoining areas, Orissa.

S. P. CHATTERJEE, Calcutta.

The results of a geographical study of the hills of Bhuvaneswar, the town of Puri and part of the Puri District are embodied in this paper. Khandagiri and Udayagiri are typical hills of this part of India. The town of Puri stands on a small hillock and first grew around the famous temple of Juggernaut. It has now extended along a strip of land facing the sea.

3. Gneissic topography of Ranchi Plateau, Chota Nagpur.

S. P. CHATTERJEE, Calcutta.

The evolution of the gneissic topography has been dealt with in this paper, and it is pointed out that the peculiar mode of weathering has resulted in dome shaped hills which dominate the landscape. A short description of Vegetation and human activities has also been included.

4. Geography of the town of Krishnagar, Bengal.

S. P. CHATTERJEE *and* B. M. ACHARYA, Calcutta.

A geographical study of the town of Krishnagar shows how river systems are affecting the development of towns of Bengal. Krishnagar was the famous capital town of Maharaja Krishnachandra. It grew up along the banks of the river Anjana around the royal palace. But subsequently with the silting of the Anjana the population migrated towards the north to a spot through which now flows the Jalangi. The latter river is now getting silted up with the result that malarial fever and disastrous floods seriously threaten the existence of the town.

5. Naturvolkers of Chittagong Hill Tracts, Bengal.

D. C. DASGUPTA, Calcutta.

Naturvolkers all the world over are directly dependent upon their natural environments. The naturvolkers of Chittagong Hill Tracts on the south-eastern part of Bengal are not exception to this rule. These people are undoubtedly of Mongolian stock, and now live in widely scattered areas of Chittagong Hills. How and to what extent geographical factors determined their daily modes of living, social and political institutions, have been discussed in this paper.

.6. The growth of a modern city.

C. M. Ramachandra Chettiyar, Coimbatore.

Coimbatore has leaped into 'The Manchester of South India', under the impetus to mill-industry given by the Great War. The growth is indicated in several ways. Agriculture and industry meet here, the latter taking up spinning and weaving of cotton, coffee, tea, cement, and tanning. Besides regional and economical facilities, there are the modern ones, of roads and railways, water supply from Siruvani, and Electrical supply from Pykara. Banking facilities are ample. Labour is cheap and abundant, though prone to strikes. Regular Town-planning schemes with provision for drainage have been taken in hand, and cope with the growing needs for more and better houses, and a population almost doubling itself in these decades. The mill industry has attained stability. Future growth and maintenance of progress may be expected.

7. Some dynamic problems of Indian Geography.

Arthur F. Geddes, Edinburgh.

The relationships of Relief, of hills to Tableland and hills to plains are statical problems; and maps to show them are a desideratum. The division between jungle and cultivation is dynamical; likewise rivers cutting back, on their beds; soil erosion, etc.

Another type of dynamical problem is the Seasonal Rhythm, and its correlation to agriculture and produce and occupations all the year round; all of which may be mapped, and graphed; that would help in finding out the really idle time and show us ways of turning it to best use. The dynamical relation of irrigation to dry farming may be shown on special graphs.

The Village House is a statical problem adapted to the family and cultivation, and to the crops and animals. The village uplift, going further, is dynamical, in devising better plans for sanitation, for cultivation, and for village life.

Agriculture requires generally, statical joint system. The joint family system, so characteristic of Indian peasant life, thus tends to be a statical one; but other forces than the needs of agriculture tend to make it dynamical. The present Indian type may break up only to reunite voluntarily, for Mutual Aid, under stress of economic forces, as in Denmark. The resulting effects of such changes on Village Life and mentality and Society are dynamical, and they tend to make new social systems with new approaches to old problems.

The haphazard growth of Villages and Towns is due to the responsible authorities not having had the geographical outlook; and their approaching their problems only as biologists, architects, Engineers or Factory Employers, etc.; and their failure to conceive of the problems as a whole, *i.e.* geographically. In Village and Town-Planning the Geographer has his special place and contribution to make.

To visualize Work and Place synthetically whether it is House, Village, Town or City, and to conceive of Uplift and Planning in accordance therewith requires geographical study. The Past, Present and Future come into these dynamical problems of India.

8. Fisheries of Cochin.

A. Karunakara Menon, Cochin.

Special geographical environment—its influence on the fisheries of Cochin.

Cochin waters teem with fish life, potential wealth lying mostly unexplored. Fisheries are marine (sea), brackish water (back water lagoons, etc.), and fresh water (river, lake, and tank fishes).

Sea and backwater are more important, Sea giving sardines and sharks; backwater, prawns and other small varieties. Fresh water is not much esteemed.

Implements and methods of catch are described. Old ones—nets, line and rod, and missiles—admit of improvement.

Fishing communities are traditional castes; and new ones are forming. Catch is disposed of—plenty as food; as manure, the rest. Much improvement is necessary in curing and preservation for export trade.

Defects under existing conditions are manifest. There is wide scope for improvement. There is little exploitation of the vast resources. Good and rare varieties may be bred. Scientific curing and scientific preparation of manure, etc. will secure great expansion of market.

9. Utilization of lands seasonally water-logged.

A. KARUNAKARA MENON, Cochin.

Paddy Cultivation on Lands submerged in Rainy Season and called *Cole* (Kol) in West Coast (Kerala).

Fresh-water-logged beds (Cole), their *distribution* in West Coast (Kerala); *situation* by back-water, canal or sea; *formation* by Rain and River-floods.

Masonry dams prevent salt-water inflow, while sluices regulate their fresh-water content. A channel, 5 feet wide and provided with sea-outlet, is enclosed between two bunds. *Into* the channel is drained, under co-operative labour, before sowing, the fresh water of the Cole; and *from* the channel, water is retaken according to requirements of growing paddy. Success depends upon sufficiency of water retained in the channel, while regulating it to expected rains and over-flows. Cheera, the Paddy sown, a three-to-four months' crop, is specially adapted to water-logged conditions. Harvest is rich, often made from boats.

The special feature is that these West Coast seasonal lakes and tanks *drain* their water *into outside* for cultivation *inside their beds*—in contrast to the East Coast ones which *retain* their water *inside* for cultivation *outside their beds.*

10. Recent irrigational changes and their effects in Grand Anicut Canal Region (Tanjore).

T. KRISHNASWAMI, Tanjore.

Tanjore Dry Area is turned into Wet by (1) The Mettur Canal, (2) Vadavar Extension.

Crops are raised with better assurance; population has grown; new roads have been laid down; a new occupation, fishery, is come. On the other hand, there is water-logging with malaria accompanying it. It also reduces fertility, forming alkalies and plant-toxins. Water-logging is due to defects in design to connect irrigated water surplusage to natural drainage lines. Designers also failed to take into account suitability of soils to wet crops; undesirability of all lands being turned over to paddy; and ryots' unwillingness to take canal water.

The lower-down-Delta land-owners complain of (1) deprivation of silt, (2) inadequate water at right season, (3) raising of river-bed, and (4) consequent danger to life. Proper drainage with rotation and manures will improve production.

11. Sugarcane cultivation in India.

GEORGE KURIYAN, Madras.

The paper deals with the climatic and edaphic requirements of sugarcane as an agricultural crop and the climate of India is studied with particular reference to the needs of the plant. The importance of sugarcane as an agricultural crop is also discussed. The area under sugarcane has increased phenomenally since 1931. The geographic distribution of the crop together with the recent trends in the increasing acreage is studied with reference to physical and other factors—particularly irrigation—which influence the cultivation of the cane.

12. Potential spas of Sind.

MANECK B. PITHAWALLA, Karachi.

Sind is unique and fortunate in possessing medicinal plants and hot springs whose curative properties have been famous.

These are due not to any kind of drying or approaching vulcanicity but severe folding and fractures of sedimentary rocks of the Kohistan Section during the Tertiary period. Not less than 20 hot springs are within 100 miles of Karachi. Water, percolating through fissured strata of anticlines, penetrates to many thousand feet depth, and gets heated in the interior. Sudden release of pressure with the original head brings up the water in a highly heated or electrified state and charged with valuable salts and gases.

Well-known are Mangho Pir, and the Laki springs; their waters have been analysed and doctors speak to their curative virtues. Government may profitably develop at once some six of them, providing modern facilities of residence and other comforts, as available at Spas elsewhere.

13. Problems of Greater Karachi—geographical solution through forming satellite towns in 12-mile circle.

MANECK B. PITHAWALLA, Karachi.

Geography provides efficient solution, at least cost, of Karachi Town-planning Problems of Land, Water, and Drainage, to cope with population largely and rapidly increasing with the expansion of production under Sukkur and Canal Colonies of its Hinterland, Sind and Punjab; with its becoming Air, Sea, River, and Rail Port nearest to the West; also with its being Province Capital.

Satellite Towns should be built within a 12-mile Radius, with independent Water-supply as follows:—

(1) Malir as garden colony with its Municipal Wells (12 miles E.).
(2) Drigh Road as the Cantonment Town for airway and the Military, water from Malir (7 miles E.).
(3) Gizri and Cliften as Riviera (3 miles S.E.).
(4) Dalmianagar as Industrial Town, water from wells in Lyari Riverbed (7 miles N.E.).
(5) Mangho Pir as Spa, wells local or water from the Hab (10 miles N.).
(6) Landhi as University Town, wells on Malir Left Bank (3 miles S.E. of Malir).

Such a scheme of Satellite Towns, interlinked by bus, tram, and Suburban Railway—all under single Municipality—gives spacious lay-out; provides for future expansion; avoids present congestion; and meets water supply problems, *at least cost,* unlike the contemplated 100-mile aqueduct from Kotri which runs into many lakhs.

14. The source of the Brahmaputra.

SWAMI PRANAVANANDA, Calcutta.

The author started his exploration work in Western Tibet in the year 1928 and studied the sources of the Sutlej, the Brahmaputra and the

Indus. The source of the Brahmaputra lies not in the Kubi glaciers as discovered by Sven Hedin but in the Chema-Yungdung glaciers.

15. The tanning industry in South India.

K. RAMAMURTHY, Madras.

Tanning is among the foremost industries of South India, and about 400 tanneries are spread all over the Presidency. Mussalman Labbais and low caste Hindus engage in the industry, the prejudices of the caste Hindus leaving this a virtual Moslem monopoly.

The principal tanning materials are avaram bark and myrobalams. Avaram bark gives a buff-coloured leather which can be used for book binding, furniture and carriage lining, etc. The liquor prepared from myrobalam fruits is a powerful tan, imparting brightness to the leather, when mixed with tanning agents. Wattle bark is imported from South Africa to supplement local avaram bark. Plans are ready to grow 200 acres in the Nilgiris with wattle.

Thus, South Indian tanning industry has the advantages of locally available tanning materials; raw hides and skins in abundance; and cheap labour. It is hoped that the tanners will take to modern methods of efficient tanning and keep down foreign competition.

16. The Cheyyar basin.

K. SUNDARESAN, Saidapet.

The region studied, lies between 12°-15′N. and 12°-45′N. and 78°-45′E. and 79°-55′E. near Vellore, consisting of two well-marked natural regions, Javadi uplands and alluvial lowlands. The Cheyyar river is the dominant life-giving factor; and promotes unity of life and nurtures a simple, hard-working peasantry. Malayalis living on the Javadi Hills are poor, almost neglected, and backward.

Their economic development is feasible. Citrus fruits, Coffee and Cinchona plantations may be introduced on the Javadis, as soil and climate are suitable and labour cheap. Kitchen gardens may be opened on hill terraces on commercial scale, as Madras is within 5 hours by road. Honey, Drumsticks, Yams and Jackfruits are their specialities.

Irrigational facilities of plains may be enlarged; and cultivated area almost doubled. Betel-leaf, Ground-nut, Castor and Sugarcane need special attention as their demand is growing. Railway facilities as suggested would improve the economic resources.

17. The traditional limits and sub-divisions of the Tamil region.

B. M. THIRUNARANAN, Madras.

The paper describes the limits of the Tamil region and its chief sub-divisions as indicated in the traditions of the Tamil people about their home land. The data available are embodied in various Tamil literary works of different periods, and they are collected, compared and examined with reference to the geographic limits set forth by the author in a previous paper (Proceedings of the 25th Session of the Indian Science Congress, 1938). The close correspondence between the geographic limits and the limits traditionally recognized suggests that the long settled peoples of this region have been well aware of its unity and individuality, as well as of its natural sub-divisions from very early times.

18. The floods of 1937 in the Tamil Nad.

B. M. THIRUNARANAN *and* V. E. NAGANATHA RAO, Madras.

Floods occurred in October in the Lower Tambraparni basin, and in November in Chingleput, North Arcot, South Arcot and Tanjore Districts.

The latter, studied as to duration and effect, are referrable to depressions, from the Bay, passing inland, bringing on spells of rainy weather which do serious damage in flat coastal lowland tracts where drainage is not rapid. Irrigation tanks conserve the rainfall for use but when anyone of connected series of tanks breaches, much damage may ensue to those lower down in addition to its own. Forecasting and Flood-warning to regulate water-storage will make them more efficient.

19. Geography of the Casuarina plant.

T. P. VENKATACHARI, Madras.

The Casuarina, an exotic plant brought from Australia and the Malayan Archipelago, early in the last century, has taken well to the sandy coastal regions of India. The Casuarinæ Equisitifolia, one of about twenty varieties of an only genus, has been introduced into India and found to thrive well in a large variety of soils otherwise left waste.

It is a leafless deciduous tree, coniferous in appearance, having inter-nodal sheaths of connated scales performing the leaf-functions. It is a hardy plant, spread almost all over India. It fertilizes the land by fixing the free atmospheric nitrogen to it.

Casuarina is a good fuel. It can be developed considerably, utilizing the culturable waste in our country, of which only about 3% is now under casuarina, and the fuel problem of the entire country can well be solved thus, and the farm-yard manure could be conserved for its proper use.

The casuarina reclaims lands, revitalizes exhausted lands, and utilizes otherwise useless lands for human benefit.

20. Geographical personality of Coorg.

K. S. VENKATARAMAN, Bangalore.

Coorg has retained its personality intact situate on Highlands of Western Ghats 3,500 ft. high, though it merges into Mysore on one side and on another only 25 miles from the sea. It receives 134 inches of rainfall with 150 rainy days; and has a climate that is temperate and humid. Sub-equatorial forests abound; Agriculture, Forestry and Plantations are main occupations, only 3,000 acres being under paddy. The population consists mainly of hardy mountaineers picturesquely garbed, with a distinct culture of their own, though having living contacts with those of the plains.

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SECTION OF BOTANY

President:—KRISHNADAS BAGCHEE, D.Sc., D.I.C., F.N.I.

Fungi

1. Taxonomic studies of Indian smuts.

B. B. MUNDKUR, New Delhi.

A short historical account of the smut collections made in India is given and it is stated that up to the end of the last century nineteen smuts had been discovered of which eighteen were new species. Six of these were named in England, nine in Germany, two in America and one in India. Types or cotypes of these smuts, with one exception, were unavailable in India.

During the present century many collections of smuts were made by Dr. E. J. Butler, included in which were thirty new species. Several other collections have also been made and the total number of smuts recorded for India up to the present time is 110.

A brief account of the investigation of forty-three collections of Indian smuts, included in which are seven new species, five new combinations and thirteen other species, is given and mention is also made of the taxonomic study of over fifty collections of sugarcane smuts.

2. On the characters of *Choanephora cucurbitarum* (B. and Rav.) Thaxter, causing a wet rot of chillies.

S. SINHA, Lucknow.

A revision of the characters of the fungus has been made and some new points observed. The development and variation in the size of sporangia on the host and in nutrient medium have been described.

Associated with the conidia and the reduced sporangia have been found conidia-like structures borne exogenously on a stalk, singly or in groups. In the latter condition, each is borne on a short ramulus which in turn arises from the stalk. These structures probably indicate a change from a sporangial to a conidial habit.

Wolf and Dastur have observed a definite peculiarity in the formation of zygospores. They found that the zygospores develop, only when the mycelium arises from conidia taken directly from the host and not from the fungus growing in the nutrient medium. A cultural study has been made which revealed the formation of zygospores from the mycelium arising from conidia taken directly from the host, or from the fungus growing in nutrient medium.

3. A new species of *Bombardia* occurring on dry twigs of *Thunbergia grandiflora* Roxb.

G. S. VERMA, Lucknow.

The size and characters of perithecia are given. The ascospores before being discharged are hyaline, vermiform 1-celled and contain oil drops. Later the discharged spores undergo peculiar structural development becoming multicellular such that in mature condition they consist of an egg-shaped head, a cylindrical tail, and one hyaline appendage at each end.

The ascospores resemble those of *Bombardia* but with the difference that whereas *Bombardia* has *dark* spores and belongs to the group Phæosporæ, the spores here even at maturity are hyaline.

4. An abnormal sterile form of *Polystictus sanguineus* Linn.

S. R. Bose, Calcutta.

The author describes an abnormal sterile form of *Polystictus sanguineus* and explains the conditions under which such sporophores can develop.

An abnormal specimen of *Polystictus sanguineus* Linn. was collected in August and September, 1937 from a bamboo kept in a very slanting position on the terrace of a dwelling house in Calcutta; *Polystictus sanguineus* ordinarily is very thin and is characteristically scarlet red. The sporophores here assumed a very much swollen appearance like a piece of loaf and the excessive growth of the context-tissue led to complete obliteration of pores on the hymenial surface where no basidia or spores could be found; but in the tissue of the sporophore only conidia of different sizes were observed. From the adjacent areas of the same bamboo-piece a number of a little thicker sporophores with elongated and irregular pores were collected in 1937 and 1938 in which basidia and spores were normal.

By keeping in a slanting position two small pieces of logs bearing *Polystictus sanguineus*—fruits within a bell jar in the laboratory with moist cotton wool at the base for about two months (July to September, 1938), abnormal development of freshly formed small fruit-bodies in the form of dendroid irregular elongations bearing pores on the lower surface were obtained. This probably explains how abnormal forms are formed in nature due to a large extent to the slanting position of the host.

5. A wet rot of leaves of *Colocasia antiquorum* due to secondary infection by *Blakslea trispora* and *Choanephora cucurbitarum* (B. and Rav.) Thaxter.

S. Sinha, Lucknow.

Blakslea trispora and *Choanephora cucurbitarum* either separately or in combination on the leaves already infected by *Phytophthora Colocasiæ* produce wet rot. They first appear on the host as saprophytes in the lesions caused by *Phytophthora*, and then behave as facultative parasites and cause an entirely different kind of decay than that of *Phytophthora*. The damage caused by the combined effect of the three fungi is much greater than that caused by *Phytophthora* alone.

In *Blakslea trispora*, sporangia (normal and reduced), sporangiola and zygospores have been found. In *Choanephora cucurbitarum*, sporangia (normal and reduced), conidia, zygospores and chalmydospores have been observed.

6. Investigation of orange rot in storage.

P. N. Ghatak, Calcutta.

A general account of the percentage of wastage caused by Fungi in oranges collected from Sylhet, Shillong and Kalimpong has been given.

The percentage of rot in Sylhet oranges varied from 5 to 53 in ordinary series and 4 to 26 in sealed series in which the stem end was treated with 2% formaline paraffin.

In the Kalimpong oranges only 4% rot was observed in ordinary series and 2% in sealed series in one lot only.

The Shillong oranges, which were untreated showed 28% rot.

From the experiments conducted, it appears that the rotting may be controlled to a great extent by sealing the stem end with melted paraffin mixed with 2% formaline.

A detailed account of other factors such as high temperature and low atmospheric humidity in checking such rots has been given in the paper.

7. Studies in the diseases of *Mangifera indica* Linn. III. On the 'die-back' disease of the mango tree.

S. N. DAS GUPTA *and* (MISS) A. T. ZACHARIAH, Lucknow.

The paper deals with the symptoms of the die-back disease of mango trees all over India, the pathological anatomy as well as the isolation of fungi from the diseased tissue, and their description.

The infection usually occurs at a variable distance below the growing point; the branch dies above the point of attack, and less rapidly, also backwards towards the base. Generally the small twigs and branches are affected. On the affected twigs, the leaves lose their healthy green colour and gradually turn brown. At the advanced stage of the disease, the leaves wither and their margins roll inwards. Eventually the leaves are shed and the twigs or branches die and shrivel up while still on the tree.

The mycelium of the fungus is wholly internal and branched hyphæ are found obstructing the lumen of the xylem vessels. It is supposed therefore that the wilting of the twigs followed by death is due to the associated fungus.

Several fungi, belonging to different genera, have been isolated and are described.

8. Studies in the diseases of *Mangifera indica* Linn. II. Investigation into the pathological histology of the fruits affected with black-tip disease.

S. N. DAS GUPTA *and* S. SINHA, Lucknow.

Histological investigation of diseased and healthy mangoes of *Dashehri* variety has been made with a view to find out the incidence of 'black-tip', and also to determine the changes caused by it.

Two main systems of vascular strands arising from the stalk of mango fruits are described, one running along the periphery of the mesocarp and the other in the region of the endocarp. Duct-like channels running parallel to the vascular system are stated to be present but none in association with the vascular strands or otherwise, in the endocarp and the inner mesocarp.

Before any symptom of the 'black-tip' is outwardly evident, a light brown substance appears in the vessels of the outer mesocarp, which is probably the first sign of necrosis. Similar deposits also take place in the cells lining the ducts which are in association with the vessels. The starch grains in the cells of the outer mesocarp become relatively less abundant than in the cells of the inner mesocarp, which is evidently more healthy. At a later stage when the etiolation is externally evident, the contents of the epidermal cells show yellow colouration. Gradually as the disease advances the contents of some of the mesocarp cells also show brown deposits. In the advanced stage of the disease, the deposits in the vessels, in the ducts and the parenchymatous cells of the outer mesocarp become continuous, and assume a dark brown colour. Affected tissues soon begin to disintegrate, the epidermal and the mesocarp cells loose their contents and identity and completely collapse into an indistinguishable mass.

9. *Neotiella catharinœa* McLennan and Halsey on *Catharinœa mülleri.*

S. N. Das Gupta *and* T. S. Sadasivan, Lucknow.

A fungus belonging to *Pezizales* was found on the axils of the leaves of a moss at an altitude of about 7,500 ft. on the way to Pindari Glacier (1936) and Milam Glacier (1937).

The fungus is identified as *Neotiella catharinœa.* It agrees in all respects with an authentic specimen of *Neotiella catharinœa.*

The moss is identified as *Catharinœa mülleri* Hamp. and C. Mull from an authentic specimen in the collection of Dr. S. K. Pande.

As far as the writers are aware neither the fungus nor the moss has been recorded from India before.

10. Effect of certain poisonous chemicals upon the spores of *Acrothecium lunatum* and *Cephalothecium roseum.*

G. S. Dhillon, Lahore.

The effect of different concentrations of 16 different poisonous chemicals on the spores of *Acrothecium lunatum* and *Cephalothecium roseum* has been studied. Spore suspensions were made in the toxic solution and then transferred to a culture medium and their viability tested. The toxins included mercuric chloride, mercuric cyanide, carbolic acid, formaline, ammonia and copper sulphate among others.

11. *Acrothecium lunatum* on *Pennisetum typhoideum* ears.

G. S. Dhillon, Lahore.

The fungus *Acrothecium lunatum,* Wakker was found on ripe ears of *Pennisetum typhoideum* collected from Sialkot, Punjab. The spores on the host measured 20·8–35·4*u* × 9·3–16·6 *u*. The fungus has been isolated and the cultural studies made. Inoculations on the young healthy green ears of the plant were successful while those on the leaves were doubtful.

12. A study of *Monascus* occurring in orange-squash.

G. S. Dhillon, Lahore.

This fungus was found forming a reddish-brown scum at the neck of a bottle from Tarnab Farm, Peshawar. In artificial cultures the fungus produced both conidia and perithecia. Certain very interesting features about the development of perithecia have been worked out.

13. Two species of *Spicaria* from interesting habitats.

G. S. Dhillon, Lahore.

A species of *Spicaria* growing on opium formed abundant conidia on the surface and chlamydospores under the substratum. The fungus was able to grow quite vigorously on Potato-glucose agar and on Challengers medium containing morphine.

Another species of *Spicaria* was found growing in very strong solutions of cane-sugar. Artificial cultures showed that the fungus can grow on up to 65% cane-sugar solution at 35°C.

Bryophyta

14. Studies in Indian hepaticæ. I. On two new species of *Leptocolea* S. from the Western-Himalayas.

S. K. Pande *and* R. N. Misra, Lucknow.

Two new species *Leptocolea himalayansis* and Pande and Misra and *L. rupicola* Pande and Misra have been described from the Western-Himalayas which were collected in the course of a botanical tour to the Pindari Glacier in October, 1936. Their habitat and respective altitude, taxonomic account and the distribution of the genus *Leptocolea* are given.

15. Studies in Indian hepaticæ. II. On the epiphyllous liverworts of India.

R. N. Misra, Lucknow.

About 26 such species of Indian hepaticæ are known. A majority of these are confined to the tropical rain forests of South India including the islands of Ceylon, Andaman and Nicobar; a few are found in the Eastern Himalayas and the Assam hills while none is known from the Western Himalayas. A comparative study of the distribution of these liverworts and the rainfall of India shows that the epiphyllous hepaticæ occur only in the regions with an annual rainfall of more than 100 inches. A detailed account of six species, including 3 new species belonging to the family Lejeuneaceæ is given.

16. Studies in Indian hepaticæ. III. On a new species of *Nowellia*; *N. indica* Pande et Srivastava, from the Western-Himalayas.

S. K. Pande *and* T. N. Srivastava, Lucknow.

The species of *Nowellia* Mitt. described here is one of the several new and interesting liverworts collected (S. K.) in October, 1937 from Melam Glaciers in the Western-Himalayas. It grows in association with *Calypogeia alternifolia* Nees and *Plagiochila sp.*; but can be easily distinguished from these because of its robust habit and darker colour.

The genus *Nowellia*, as at present known, comprises 5 species. One of these *N. caledonica* St. is endemic to New Caledonia, while *N. curvifolia* (Dicks) Mitt. is widely distributed in many parts of the world. *N. dominicensis* St. and *N. Wrightii* (G.) St. occur in the islands of Dominica and Guadelopeu, the latter being also found in Cuba. *N. borneensis* St. is confined to the islands of Borneo and the Philippines.

The Himalayan plant described above shows certain variations in the characters of the perianth and the male shoot from *Nowellia*; but the fertile material of both the male and the female plants is rather scanty and the authors have, therefore, included the himalayan plant under *Nowellia*.

Pteridophyta

17. Some observations on the Microsporocarps, Microsporangia and the male prothallium of Azolla pinnata, R.BR.

B. N. Mulay, Karachi.

1. The microsporocarps sink within 3–6 days after they are freed from the plants.

2. Rudimentary glochidia are present on the massulæ of the specimens studied from Lucknow, Agra, and Baroda. The processes of the massulæ are described.

18. Fertilization in *Azolla pinnata*, R.BR.

B. N. MULAY, Karachi.

In spite of ample literature on the life history of Azolla, there are certain points which are not as yet definitely settled.

The author has discovered that fertilization of *Azolla pinnata* occurs in the ground below the water, a fact which was not previously known.

Angiosperms. (i) Morphology

19. The development of the gametophytes in *Fumaria indica* pugsley.

(MISS) S. RAI, Lahore.

1. The archesporium in the microsporangium differentiates as a hypodermal layer of 8–10 cells.
2. Microsporogenesis and the development of microspores is normal. The meiotic divisions are of simultaneous type. The diploid number of chromosomes is 22. Usually, the microspores in the tetrads are arranged tetrahedrally, but in a few exceptional cases linear arrangement was also observed. Cytokinesis takes place by the process of furrowing. The pollen grains before liberation from the microsporangium are bi-nucleate.
3. The tapetum is entirely derived from the parietal tissue. Its cells, at maturity, become bi-nucleate and each nucleus contains several nucleoli. No periplasmodium is formed.
4. The archesporium in the ovule consists of two to four hypodermal cells of which only one is functional.
5. The functional archesporial cell after cutting off the wall cell divides twice to form a linear or T-shaped tetrad of four megaspores. The chalazal megaspore, as usual, gives rise to an eight-nucleate embryosac.
6. The mature embryosac is of the normal angiospermous type.

20. Studies in the order Parietales II. A contribution to the morphology of *Garcinia livingstonii* T. Anders.

V. PURI, Meerut.

The material was collected from Saharunpur. All the flowers examined are carpellate having about 15 staminodes which often show development up to the reduction division of the microspore mother cells. The disc on which the ovary is supported is interpreted to be a luxuriant outgrowth of the torus. The vascular anatomy of the ovary presents evidence for the fact that the placental region of the ovary is formed by the fusion of only two margins and that the remaining two margins lie in the periphery and have become sterile, so that each carpel bears only one ovule.

The development of the embryo-sac proceeds after the *Normal*-Type. No evidence of fertilization could be obtained although many cases were observed where the ovules, without any embryos, were seen enlarging in size.

21. Determination of sex in plantain flowers.

A. C. JOSHI, Benares.

The flowers of plantain (*Musa paradisiaca* L.), are generally functionally unisexual. The lower flowers of a spike are female and develop into fruits, while the upper are male and fall off after blooming. If, however, in a spike, the female flowers which have begun to develop into fruits are removed, the flowers in the upper part which would have differentiated as males also develop functional pistils and form fruits. This shows that the sex of the flowers in this plant is determined by the amount of nourishment available.

22. Origin of the lateral styles.

A. C. Joshi, Benares.

Lateral styles have become important in the phylogeny of the carpel on account of the recent hypothesis of Dr. Thomas about the origin of the Angiosperms. His view is, however, mostly based on evidence from fossils. In the present paper an attempt has been made to elucidate the origin of the lateral styles by a comparative study of the living forms.

The systematic study of the distribution of lateral styles in various families shows that they are generally associated with one- or few-ovuled carpels, which are commonly believed to have been derived by reduction from many-ovuled forms. They are most distinct in carpels with a single basal ovule. In *Wormia* (*Dilleniaceæ*), the carpels are many-ovuled and the styles terminal in most species. In *W. triquetra*, however, the carpels are many-ovuled in the early stages only. In later stages only one or two ovules develop; the others abort before fertilization. Associated with this the style is lateral. It is, therefore, clear that lateral styles are the result of reduction in the number of ovules. When the number of ovules in a carpel decreases, in many cases the ventral side of the carpel undergoes reduction without any corresponding reduction of the dorsal side. As the two sides must necessarily keep together, the result is the development of a lateral style.

23. The origin of the angiosperms : A review of the present position.

A. C. Joshi, Benares.

The angiosperms still appear to be a monophyletic group, but this conclusion can no longer be based on the great uniformity of their gametophytes or the method of endosperm development. The different types of embryo-sacs are not confined to related families. The *Frittilaria*-type of embryo-sac, which is in no way less peculiar than the phenomenon of double fertilization, has appeared independently in such families as Tamaricaceæ, Piperaceæ, Euphorbiaceæ and Liliaceæ the strongest argument in favour of the monophyletic origin of the angiosperms is the great resemblance between the Ranales on the one hand and Alismales and Butomales on the other.

If the angiosperms are monophyletic, the dicotyledons are certainly to be regarded as the more primitive group, but it is quite possible that the flowers of primitive dicotyledons were trimerous. The monocotyledonous embryo appears to have originated from the dicotyledonous by the suppression of one cotyledon. There seems to be now no evidence for syncotyly.

Most of the morphological evidence is in favour of regarding the woody discotyledons as more primitive than the herbaceous, but the evidence from chromosome numbers goes against this.

In recent years the evidence in favour of the Ranalean origin of the angiosperms has increased, but it cannot be yet regarded as conclusive.

The Angiosperms appear to have originated from the Pteridosperms, but the structure of the modern forms does not support the hypothesis of Dr. Hamshaw Thomas.

24. Origin of the seed habit.

A. C. Joshi, Benares.

The paper gives a review of the evidence in favour of the homosporous ancestry of the seed plants. There is no proof for the heterosporous origin of seed plants. If the size of the pollen and seed spores either in the gymnosperms or angiosperms is measured, no marked difference is seen between the two. In some cases the pollen spore is even larger than the seed spore. The heterosporous Pteridophyta show no other resemblance to the seed plants. On the other hand, there are many features common to the eusporangiate ferns and the seed plants. The differentiation of sex in the gametophyte which is associated with seed habit can be believed to have originated from the conditions found in the Equisetales. Similar differentiation of sex in the gametophyte also occurs in the homosporous ferns, though it is not seen so conspicuously.

25. Embryo-sac and pollen development in *Iphigenia indica* (Liliaceæ).

A. C. Joshi, Benares.

The ovule is anatropous, and possesses two integuments of which the inner forms the greater part of the micropyle. The nucellus is small in amount and mostly disappears by the 2-nucleate stage of the embryo-sac. Only its conical apex persists in the later stages. The nucellar epidermis divides periclinally. There is a single archesperial cell, which cuts off a parietal cell. The megaspore-mother cell gives rise to a row of three or four megaspores, of which the chalazal develops into the embryo-sac. When there are three megaspores, the lower number appears to result from the chalazal dyad directlly functioning as a megaspore. The development of the embryo-sac, therefore, corresponds to either the *Normal*-type or the *Allium*-type. Transitional stages between the two types of embryo-sac development are also seen. Even the non-functional megaspores generally develop up to the 2-nucleate stage and sometimes may become prominently vacuolated and simulate 2-nucleate embryo-sacs, though they never reach that size. The mature embryo-sac has two peculiar features. Firstly, the synergidæ generally do not develop any vacuoles. Secondly, the antipodals become many-nucleate. They may also increase in number. Up to 20 nuclei have been counted in one antipodal. The antipodals persist for some time even after fertilization. As they disorganize, they form a plasmodial mass. Fusion of nuclei in groups of two or more is commonly seen in the antipodals.

Pollen development has been studied particularly with regard to the position of the generative nucleus. It appears that this has a fixed position opposite to the single furrow of the grain.

The *n* number of chromosomes is 11.

26. Some abnormal flowers of *Argemone mexicana* and their bearing on the morphology of the gynæceum of Papaveraceæ.

A. C. Joshi, Benares.

Abnormal flowers of *Argemone mexicana* have been collected showing complete transformation of various floral parts into green leafy structures. Such flowers show the same number of leafy carpels in the gynoecium as indicated by the Candollean hypothesis. The evidence from them, therefore, goes against the views of Saunders and Dickson.

27. Morphology of *Tinospora cordifolia* Miers, with a discussion on the origin of the single integument, nature of synergidæ and relationships of the menispermaceæ.

A. C. JOSHI, Benares.

The carpels are at first two-ovuled, but later one ovule aborts and the carpels at the time of fertilization are only one-ovuled. The functional ovule is amphitropous and possesses only one integument, which seems to have arisen by the fusion of two integuments due to lack of space inside the carpel and consequent pressure on the ovule. The development of the embryo-sac corresponds to the *Normal*-type. The synergidæ appear to be of the same nature as the egg. The family Menispermaceæ is more closely related to the Ranunculaceæ than to the Magnoliaceæ.

28. Relationships of the *Lythraceæ* and allied families.

A. C. JOSHI, Benares.

Embryological characters of the *Lythraceæ* and *Sonneratiaceæ* have been compared with the various families of the Centrospermæ. The comparison shows great differences, and goes against the view of Hutchinson that the order Lythrales has been derived from the *Caryophyllales.*

29. Morphological and cytological studies in Scrophulariaceæ.

V. K. SRINIVASAN, Annamalainagar.

1. *Angelonia grandiflora* C. Morr. The Ovary of *Angelonia* has an indefinite number of ovules attached to an axile placenta. The ovules are anatropous. There is a single thick integument and a reduced nucellus. The integument later on fuses with the nucellus. There is a tapetum of integumentary origin. The antipodals are ephemeral. The synergids are persistent. They persist till about the early stages in the development of the embryo. No endosperm haustorium, either chalazal or micropylar is to be seen. The development of the embryo is normal.

The haploid number of chromosomes is ten. The diploid number of chromosomes is twenty. The bivalents at the meiotic metaphase show secondary association.

The basic chromosome number based upon maximum association is five.

2. *Dopatrium lobeliodes,* Benth. The haploid chromosome number is seven. No endospermal haustonium is formed in this genus also. It resembles Angelonia in all details including the persistence of the synergids till a very late stage.

3. *Russelia juncea,* Zucc. The haploid chromosome number is ten. The development of the embryo-sac is described. After the two-nucleate stage the embryo-sac degenerates. Pollen formation is normal and no marked abnormality is seen in the meotic division of the pollen mother cell. The absence of seed formation is therefore attributed to the early degeneration of the megaspore.

30. Development of the female gametophyte in *Capparis aphylla* Roth.

(MISS) S. RAI, Lahore.

Megasporogenesis is normal—the hypodermal archesporial cell cuts off a wall cell, and later divides twice to form a linear row of four megaspores. As usual, the upper three megaspores degenerate, and the lowest one develops into an eight-nucleate embryo-sac of the normal angiospermous type. The cells of the antipodals get organized much earlier than those of the egg-apparatus, and they begin to disintegrate by the time the latter are formed. The synergids have prominent beaks and also possess lateral hooks.

31. Development of the female gametophyte in *Oligomeris glaucescens* Cambess.

P. C. Joshi, Lahore.

Soon after the young ovule makes its appearance as a small conical protuberance, the archesporium gets differentiated. It consists of 2–4 hypodermal cells, but only one is functional which directly transforms into a megaspore mother cell. It divides transversely into two components of which the upper one soon disintegrates, while the lower one again divides transversely into two megaspores. The chalazal megaspore gives rise to an 8-nucleate embryo-sac by three successive divisions. The mature embryo-sac is of normal angiospermous type. The antipodals soon disintegrate after their formation.

32. Observations on the pollination, and the phenomena connected with it in *Eugenia jambolana.*

N. K. Tiwary, Benares.

Circumstantial evidence and cytological studies on the pollen tubes in artificially germinated as well as in the pollen grains germinating on the stigma indicate that fertilization in the investigated cases, in *Eugenia jambolana* does not take place. The study has also revealed an extraordinary phenomenon, that during germination the pollen grain nuclei degenerate. The tubes are accordingly enucleated and might possibly however, furnish traumatic stimulus for the development of the embryos.

Furthermore flowers are found literally invaded by a swarm of Thrips which lay their eggs in the nectary from which larvæ develop in due course. It appears possible that injuries resulting from the activities of these insects also stimulate the development of the embryos.

The anatomy of the style is also described.

Angiosperms. (ii) Anatomy

33. Formation of false growth rings in chir pine (*Pinus longifolia,* Roxb.) and its relation to growth factors.

K. Amad, Dehra Dun.

A study of the false rings of chir pine was made and the data collected during the years of investigation have brought out some relation between formation of false growth rings and abnormally high rainfall during the monsoon. At Dehra Dun, when the rainfall is about normal from May to August, the cells formed from May onwards to the end of the growth season, are uniformly thick-walled. On the other hand, when the rainfall from May to August is abnormally high, thick-walled cells are produced from the middle of May to the end of June and thin-walled cells during July and August, and again thick-walled cells from September to the end of the growth season. Thus, it will be seen that abnormally high rainfall during the later part of the monsoon has some relation with the production of thin-walled cells during these months. Furthermore, these thin-walled cells produced later in the season, are responsible for bringing about the false growth rings in chir pine.

34. Relation between cambial activity and foliar development in some forest trees.

K. Ahmad Chowdhury, Dehra Dun.

The object of this paper is to report the data that have been collected for some forest trees at Dehra Dun regarding the relation between cambial activity and foliar development.

Seven species chir (*Pinus longifolia*, Roxb.), cutch (*Acacia catechu*, Willd.), jaman (*Eugenia jambolana*, Lam.), laurel (*Terminalia tomentosa*, W. & A.) sal (*Shorea robusta*, Gaertn. f.), semul (*Bombax malabaricum*, Dc.) and teak (*Tectona grandis*, Linn. f.) were studied and not a single one showed cambial activity in the main trunk when the twigs and the small branches did not show any sign of foliar development. This, however, does not necessarily mean that the coming out of new leaves is an indication of growth in the main trunk, for, in a number of cases occurrence of cambial activity was detected two to three months after the development of new foliage.

35. Systematic anatomy of *Sesamum laciniatum* Klein. with special reference to its mucilage glands.

M. Sayeedud Din, Hyderabad (Deccan).

1. The structure of the mucilage glands in *Sesamum laciniatum* Klein. is described and the presence of ordinary trichomes, glandular trichomes, and absorbing hairs along with mucilage glands are reported.
2. A special feature of the leaf is that the epidermal cells, especially towards the margins become enlarged, most probably for water storage.
3. One more species is added to the existing list to show that such glandular hairs are characteristic of the genus *Sesamum* of the *Pedaliaceœ*.

Physiology and Ecology

36. Phosphorus nutrition of wheat.

S. M. Sircar, Calcutta.

An experiment is described on wheat (Pusa 52) grown in sand culture some with fertiliser and others under phosphorus deficiency. A comparison with fully manured plants has been made and the revival of synthesis by addition of phosphorus after a period of starvation is claimed.

37. A study on the rate of respiration in relation to nitrogen metabolism of potato tuber.

S. M. Sircar, Calcutta.

An apparatus is designed to maintain simultaneously the necessary conditions for allowing the cut discs of potato tuber to respire aerobically for a considerable time in an atmosphere free from carbon dioxide accumulation, and for salt absorption and water supply to the evaporating cells without interfering with aeration and carbon dioxide measurement during the course of the experiment.

Changes in the nitrogen content as a result of increased metabolic activities have been investigated. The increase in protein nitrogen, depending on the availability of oxygen, is observed.

In the synthesis of protein, the behaviour of nitrogen fraction has been noted.

That the disappearance of amino-acids in the synthesis of protein is due to the process of oxidative deamination, to set free ammonia to form the amide which synthesizes the protein, has been suggested.

Absorption of inorganic nitrogen and increase in protein nitrogen with other soluble fractions increased have been noted.

38. March of transpiration of a leaf from the earliest stage to its fall.

P. Parija *and* B. Samantarai, Cuttack.

Transpirations of the leaves of deciduous plants *Helianthus annus* and *Datura alba* from the earliest measurable stage to their fall were recorded. Transpiration of *Helianthus* leaf was observed under natural conditions, and the march of transpiration from day to day was most influenced by changes in humidity. Observations in *Datura* also showed similar results. Subsequent work on *Datura* was done under controlled humidity.

The transpiratory rate per unit area in both plants rises with age, then falls to a steady value and ultimately declines.

The period of the completion of life cycles attainment of steady value and the eventual completion of the decline is given.

39. Observations on the vegetation found round about Laki and Manga Pir—two hot springs in Sind.

B. N. Mulay *and* G. D. Bhavani, Karachi.

The vegetation near about these two hot springs occurs as an open formation, only a few species representing the Natural Orders *Salvadoraceæ, Tamaricaceæ, Cappridiaceæ* and *Asclepiadaceæ*. The vegetation of Laki shows a marked contrast to that of Manga Pir hot springs where almost identical ecological conditions prevail. At Manga Pir *Tamaricaceæ* is not represented, *Salvadoraceæ* is only slightly represented, *Capparis aphylla* is common. *Euphorbia tirucalli,* Linn., and the date palm *Phoenix dactylifera,* Linn. are at their optimum. Cucurbitaceæ is amply represented. The scanty phanerogamic vegetation at Laki is correlated with the prevalence of extremes of temperatures.

As regards the cryptogamic flora round about the Laki springs (temp. about 40°C) the group *Thallophyta* is represented by the sulphur bacteria occurring in red patches. In the actual hot spring *Spirogyra, Ooedogonium, Phormidium, Oscillitoria* and *Diatoms* are well represented. The *Cyanophyceæ* in Manga Pir springs does not show the same abundant development that it shows at Laki and the diatoms are almost lacking.

40. Some ecological observations on the life history of Azolla pinnata, R.BR.

B. N. Mulay, Karachi.

Only one species of the genus *Azolla*, namely *Azolla pinnata* is found in India. The ecological study of this species in different places, shows a possibility that there may be 2 or 3 varieties of this species in India. In the present paper *Azolla pinnata* is studied from this point of view and the divergences of the development or otherwise found in *Azolla pinnata* at different places recorded.

41. The flora of Mussoorie.

R. R. Stewart, Rawalpindi.

Mussoorie has a very rich and varied flora. Nearly 1,100 species of higher plants and 100 ferns have been reported from an area of about

120 sq. miles and between 3,500 and 7,500 ft. Collett reports 1,326 species of flowering plants and 124 ferns from Simla but he takes in an area of about 500 sq. miles with a range of altitude from 2–10,000 ft. On the whole the trees and shrubs of the two regions are the same but Mussoorie has about 20 inches more rain during the monsoon which makes possible a varied epiphytic flora of lichens, liverworts, mosses, ferns and higher plants. In addition Mussoorie is much richer in orchids, aroids, and Gesneraceæ.

Conifers are much less numerous and important about Mussoorie than they are in the Simla region. Only *Pinus longifolia* is abundant. *Quercus incana* is the chief tree from 5,000 ft. to the top of the ridges. Most of the trees above 5,000 ft. are broad leaved sclerophylls as eight months of the year are comparatively dry. There is a great variety of trees and shrubs in the Sub-Himalayan tract from 3,500 ft. to the zone of the oaks but none are very large. Only *Pinus longifolia* is common in pure stands.

Although the collector is not likely to find new species of higher plants about Mussoorie there are probably a good many species to be found in the lower valleys which have not yet been listed as occurring in the area.

Palæobotany

42. On the anatomy of a fossil dicotyledonous wood from Nailalung, Assam.

K. AHMAD CHOWDHURY *and* S. GHOSH, Dehra Dun.

A study of a fossil from Nailalung, Assam has been made and identified as *Cynometroxylon indicum*, a new form genus. An anatomical description is given which shows greatest affinities with genus *Cynometra* of the *Caesalpineæ.*

43. The Pleistocene flora of Kashmir, Part (I).

G. S. PURI, Rawalpindi.

The present paper deals with the flora of the Karewa beds of Kashmir described from Laredura at 6,000 ft., Dangarpur 6,300 ft., Ningal Nullah at 9,000 ft., Gogajipathri at 8,800 ft., Botapathri at 9,500 ft., Luddarmarg at 10,600 ft., and various other spots in the Pir Panjal Range. The specimens from the second, fourth and sixth localities were presented to Lucknow University for investigation by the late Dr. S. K. Mukerji. As early as 1864 Godwin Austin drew attention to the occurrence of fossil leaves from Luddarmarg and Gogajipathri. Since then Middlemiss, Wadia and H. de Terra have collected fossil plants from these places. A few leaves were first identified by I. H. Burkill for Middlemiss. Wodehouse identified some pollen grains from material sent to him by Dr. H. de Terra. Dr. B. Sahni, Dr. S. K. Mukerji, and Dr. R. R. Stewart made some preliminary studies. Dr. S. C. Varma also identified some pollen grains from De. Terra's and Dr. Sahni's collections.

De Terra's collection, together with others made later by Sahni, were lent to the author who started work on this material and Stewart's collection from the first and third localities.

About 90 species of angiosperms, gymnosperms and filicales distributed in 25 families and 51 genera have been described from leaves, fruits and seeds; many different types of pollen grains, fungal spores, diatoms and other fossil remains have also been examined. The flora is of lacustrine origin and as suggested by Godwin Austin, Middlemiss, Wadia, Sahni and others their occurrence in these elevated localities indicates that the beds have been uplifted since they were first deposited. The species described are modern types still living in the Kashmir valley or adjacent regions. There is a great deal of difference in the flora of the different localities.

Taxonomy

44. Euphorbiaceæ of the town of Dacca and its neighbourhood.

H. K. DUTTA, Dacca.

The paper describes some species of Euphorbiaceæ of Dacca already recorded in Prain's Bengal Plants except *Croton sparciflorus* which is a species introduced in Bengal about 30 years ago from South Africa.

General

45. The work of the Forest Research Institute, Dehra Dun.

R. MACLAGAN GORRIE, Edinburgh.

The present staff for research work consists of about 30 gazetted officers; a few are forest officers and the rest are specialists recruited to deal with some particular problem or line of research. Work at Dehra Dun is much more diverse than at any of the well-known Forest Products laboratories in Europe or America, because silviculture and forest protection in their widest sense are added to timber utilization and marketing, Six main branches: silviculture, forest botany, entomology, utilization, marketing and chemistry, are subdivided into sections wherever necessary.

Silvicultural research aims at obtaining a regular supply of valuable timber trees from all ground capable of growing timber. There are some 300 species of recognized economic importance amongst the total of about 2,500 tree species of India and Burma, and each presents a separate problem in rate of growth studies, regeneration technique to obtain natural or artificially planted young crops, correct size for efficient utilization, and marketing of its timber. Further, there is the management and improvement of the huge areas of reserved forest which are incapable of producing any valuable timber, but which are of vital importance to the local inhabitants as a source of fuel, rough building timber, grazing, and fodder. The policy of government as laid down 50 years ago is to make such areas as productive as possible, and the lessons learnt from them should be applicable in improving all village common lands.

SECTION OF ZOOLOGY

President:—C. R. NARAYAN RAO, M.A.

1. On a new gregarine from the intestine of the Indian centipede—*Cormocephalus dentipes* Poc.

M. CHAKRAVARTY, Calcutta.

The gregarine dealt with in this paper belongs to the genus *Stenophora*, in having its epimerite simple in structure, spores ovoidal and gametocysts rupturing by simple dehiscence. This is for the first time that a *Stenophora* is being reported from the centipedes. The author has described the morphology and life-history of this gregarine in detail.

2. The morphology and life-history of a Coccidian *Myriospora polydorae* n.sp., in the body-cavity of *Polydora ciliata.*

P. N. GANAPATI, Madras.

A polysporocystid Eimeriid Coccidian has been found infecting the tissues of the body-cavity of a polychæte, *Polydora ciliata.* The merozoites are gregariniform bodies attaining considerable dimensions. A sexual differentiation is evident very early in the development of the merozoites. A sexual multiplication of the parasite by schizogony has not been observed to take place inside the worm. The merozoites directly give rise to the gametocytes. The microgametocyte breaks up into 60 to 100 microgametoblasts, each of which gives rise to a few male gametes. The oocyst produces 40 to 60 sporocysts each containing 12 to 20 sporozoites. The Coccidian under consideration comes under the sub-family Aggregatinæ (Family Eimeriidæ) and has provisionally been assigned to the genus *Myriospora.*

3. Studies on the flagellates (Mastigophora) found in the intestines of the common Indian snakes.

A. N. MITRA, Calcutta.

In this paper the author gives the morphology of the flagellates parasitic in the intestines of snakes dying in the Zoological Garden of Calcutta. Affinities of these flagellates have also been discussed.

4. On *Cœloplana* spp. discovered by Prof. Tattersall at Krusadai Island, Marine Biological Station, Gulf of Manaar.

D. W. DEVANESAN *and* MR. S. VARADARAJAN,

South Malabar, (S.I.).

Prof. W. M. Tattersall of the University College (Cardiff) who visited the Krusadai Biological Station in January–February 1938, while examining sea-weeds, came across a single specimen of *Cœloplana.* As he was due to leave the next morning, he entrusted the work of identifying and describing the animal to us.

The large number of species (ten) of Cœloplana hitherto described prevents us from quickly deciding whether the Krusadai species is new to science or not. Further, it has not been possible to decide whether the variations seen in the number and arrangement of the respiratory tentacles are different specific characters indicating the presence of two species in the *Cœloplana* community off Krusadai. This is being investigated.

The Krusadai Cœloplanæ are littoral in habitat and are found in association with sea-weeds chiefly *Halimeda opuntia*. The gastro-vascular system is transparent for the most part and the circulation of the food-material can be seen under the microscope; the peripheral canal is absent. The tentacles in addition to other functions may serve for the purpose of adhering firmly to the substratum as the area where they occur is subject to the action of the surf. The genus seems to be confined to the old world.

5. A brief survey of the development of the knowledge of Trematode fauna of India.

G. D. BHALERAO, Mukteswar.

The author gives in this paper a brief but a complete outline of the work done on the adult trematodes in this country, their larval forms and their life-history, dating from 1841 up to the present day.

6. Observations on the anatomy of *Acanthostoma burminis* (Bhalerao, 1928).

G. D. BHALERAO, Mukteswar.

This parasite was described by the writer in 1926 from the river-snake, *Natrix piscator*, in Burma. It has since been recorded from the same host from several localities in India by different authors. As remarked by Stunkard the members of the genus *Acanthostoma* exhibit some peculiarities in their anatomy, particularly in respect of the alimentary canal. The parasite is re-examined and some new important observations are made.

7. Discussion on the validity of *Moniezia denticulata* (Rudolphi, 1810) (= *alba* Perroncito, 1879) Blanchard, 1891.

MOHAMMAD AMIN, Lahore.

Theiler (1924) in her critical review of the genus *Moniezia* doubted the validity of *Moniezia alba* and *Moniezia denticulata*. Baer (1927) considered these species identical, both being characterized by the absence of interproglottidal glands. Taylor (1928), while examining the variation in the structures of the genus *Moniezia*, took up the question of the validity of *M. alba*. He examined Perroncito's type material of this species, but could not see definite glands, which he attributed to unsatisfactory staining. In Stiles and Hassal's original *M. alba* material, however, he could see glands of the linear character. Thus he could synonymize *M. alba* with *M. benedeni*. Southwell (1930) and Bhalerao (1935), on the contrary, still regard *M. denticulata* as a distinct species.

To ascertain the validity of the species under discussion, the author of this paper examined a series of twenty-one complete specimens of *M. expansa*, freshly collected and stained. He observed that there is a regular decrease in the average number of glands present per segment from 51 to 0·03, in twenty-one species. It is therefore highly probable that examination of more material might reveal a worm without any gland. He therefore concludes that *M. denticulata* is not a valid species, but is only a synonym of *M. expansa* and not of *M. benedeni* as regarded by Taylor (1928).

8. On a new variety of *Avitellina sudanea* (Cestoda) with a note on the anomaly in its genitalia.

MOHAMMAD AMIN, Lahore.

This paper contains an account of a new cestode worm, namely, *Avitellina sudanea* var. *panjabensis*. The worm differs from the typical *A. sudanea* in the shape of the ovary, the absence of intersegmental septa, and the uteri and paruterine organs being disposed alternately in adjacent segments, the eggs in the paruterine organs being discharged into the ventral excretory vessels through an opening in the wall of these organs. Moreover, the intersegmental fibrous pad, appearing rather late in this form, is thin and never so prominent as in the typical form.

A point of interest observed in this form is that some segments contain double set of genitalia, one of the two being, however, generally attenuated. This seems to point to a phylogenetic relationship between *Avitellina* and some other double genitaloid genera of Anoplocephalidæ.

9. On the nematode *Camallanus anabantis* Pearse.

G. K. CHAKRAVARTY, Calcutta.

From the material found in the intestine of *Anabas testudineus* in Siam, Pearse in 1933 erected a new nematode species *anabantis* under the genus *Camallanus*. Some time ago the author encountered the same species of worms in *A. testudineus*. Those worms, however, exhibit differences from the description given by Pearse and in this paper those points of difference have been discussed by the author.

10. The recent placuna pearl fishery in Baroda and some notes on the window-pane oyster.

S. T. MOSES, Baroda.

History of the Baroda pearl fishery since the discovery of the window-pane oyster in 1905. The Pearl fishery of May, July 1938. A relief work. *Modus operandi* of the fishery. The quantity of 'dead' oysters needed to yield a tola of pearls. Measurements of sizes and gauging of quantities available. The habitat of the 'live' oysters. Action of currents and experiments in current determination. Spawning season. Growth rate and location of pearls. Age of oyster and pearl production. Abundance of pearls. Presence of peacrabs. Bays where pearls are abundant are favourite fishing grounds. Among fish found are shoals of wrasses (*Platyglossus* Spp.) and Tetrodons (inedible).

11. The development of *Temnopleurus toreumaticus* (Klein).

M. ANANTARAMAN, Madras.

Mortensen, in his 'Studies' (1921), describes the development of this form up to the age of 12 days. Aiyar (1935) was the first to trace the entire development of a Temnopleurid, *Salmacis bicolor*. Onoda (1936) describes an almost fully formed larva, 25 days old, of *Temnopleurus toreumaticus* from Goza, Japan. That stage of his corresponds with the 11 days-old stage of mine from Madras. The present work is the first connected account of the development of this species.

The eggs are very small, about 79 microns in diameter and not quite transparent. The cleavage processes go very rapidly and in about 8 hours gastrulation sets in. The typical pluteus stage with short post-oral arms is attained at the end of a day, and the amnion is seen to be formed as a solid mass of cells by the close of the second day. Pigment spots, deep brown in colour, appear during the third day; the postero-dorsal arms on the sixth day; the dorsal arch on the seventh day; the four ciliated epaulettes, the postero-lateral processes, and the posterior transverse rod on the eighth day; and the pre-oral arms on the tenth day.

By the eighteenth day, the larva is fully formed with a prominent Echinus-rudiment. The two pairs of the main arms, namely, the post-orals and the postero-dorsals, are very broad at the base and the middle, and abruptly narrow along the distal third. Each of the four main arms is provided with a ciliated epaulette at the base. The larval body in general is covered with deep brown spots which are specially concentrated at the tips of all the arms. This peculiar shape of the main arms and the occurrence of the pigment spots at the tips of the arms have not been observed in this species either by Mortensen or Onoda. But in *Temnotrema scillae*, Mortensen (1937) figures and describes identically shaped larval arms.

The post-oral and postero-dorsal rods are fenestrated and provided with lateral spines. The body rods are coarsely spined and do not form a basket structure. Secondary lateral processes are present on the dorsal arch, which, Onoda says, were not developed in his larvæ. The posterior transverse rod is characterized by two small spines in the middle and by each end forking laterally; the upper branch is simple and the lower antler-like. The ventral transverse rods cross each other. The details of the formation of the first pedicellaria, of the amnion, and the cœlom have also been investigated.

Metamorphosis occurs in 20 or 21 days after fertilization. The just-metamorphosed urchin measures, without spines, 0·5 mm. across and attains a size of 7 mm. on the forty-second day. It was possible to rear several hundreds of healthy urchins which are growing satisfactorily in the Laboratory aquarium tanks.

12. Development of *Herdmania pallida.*

V. O. SEBASTIAN, Madras.

The anatomy of *Herdmania pallida* has been worked out by Das (1936). He has described the egg and the sperms but the development was not attempted by him. The following is a preliminary account of the development of *Herdmania pallida* from the time of fertilization to the time of larval fixation.

There is variability in regard to the inclusions of the ovum. The first division takes place generally after 35 minutes from the time of fertilization and the early stages of segmentation are completed rapidly and are over by one hour and a half after fertilization. The escape of the larva is accomplished by the rupture of the chorion, and liberation takes place in 8 hours. The larvæ appear as minute vigorously moving specks in water. There are 3 adhesive papillæ. The tail when moving bends in perfect arcs, the notochord being tough and rod-like. An interesting feature is the presence of 3 sense organs in the brain vesicle, the first being the otocyst consisting of a stalk with a ball of black pigment situated at its top, the second, the eye in the form of a round transparent organ and the third a structure of unknown function similar to but smaller than the eye.

Free swimming life is only for about 1 to 2 hours after which the larva fixes by the adhesive papillæ. The tail degenerates and permanent fixation is by ectodermal ampullary processes which are four in number. Other details in regard to development are also given.

13. On the bionomics, structure and physiology of respiration in an air-breathing brackish water eel, *Pisoodonophis boro* (Ham. Buch.).

B. K. DAS, Hyderabad (Deccan).

Bionomics.—Fishes of both sexes, varying from 53·2 cms. to 65·1 cms. in length, have been obtained this year from the backwaters of the river Adyar (Madras), generally from the muddy and sandy bottoms, and studied alive during the month of May last. They are found in shallow depths near the sea-shore as well. They are captured in greater numbers during the evening after dusk and at night than in the day time when they generally lie buried in the mud. They swim about in water, more or less, like an aquatic snake. They are said to breed from January to April, and during pairing they have been observed to twine round each other: lots of young ones are usually found in March. The tail is very sensitive and slightly prehensible, and, as a rule, the fish buries itself with the help of the tail-end which makes a screw-motion in the mud, thus allowing itself to gradually sink down, and ultimately it may disappear completely inside the soft mud, and may emerge again in about 10–15 minutes' time. They are never found exposed to the mud-flats. They do not come so frequently to the surface of water to breathe atmospheric air as most other air-breathing fishes do, but are adapted to carry on aerial respiration (in addition to normal gill-breathing) by the help of their opercular chambers.

Structural modifications.—In correlation with the air-breathing habit, amongst other details, the following chief adaptations and modifications have taken place:—

(i) Mouth-cavity is a wide chamber, and has become highly vascular—its floor and sides are more vascular than its roof, and subserves aerial respiration=Bucco-pharyngeal respiration.

(ii) Inner surfaces of the gill-arches also highly vascular—possibly an adaptation to an air-breathing habit.

(iii) Opercular chambers—very spacious, elastic, sac-like, highly vascular structures, fully modified and most important in connection with the aerial respiration—their inner walls include a dense net-work of blood-capillaries which constitute an effective mechanism for the exchange of gases.

(iv) Gills—there are four gills on each side, but they are relatively small for the size of the fish. The inter-branchial septum slightly persists towards the proximal region of each holobranch. The pre-axial hemi-branch is longer than the post-axial one. Secondary branchial folds are quite prominent and are small, oval, leaf-like structures, and best developed on the 3rd gill which is the largest of the series. The hyo-branchial cleft is comparatively large and admits most of the air inside the branchial chamber during aerial respiration. The gill-opening is fairly small lying opposite to the base of the pectoral fin.

Physiology of respiration.—There are two modes of respiration in this fish:—

(i) Typical branchial respiration as carried on by the fish to a large extent: In this case the fish takes a current of water which passes backwards and ultimately bathes the gills—the opercular chambers acting as bellows. In a dozen of fishes studied the normal branchial oscillations were 78, 100, 108, 110, 116, 118, 121, 126, 136, 144, 158 and 166 per minute at a temperature varying from 91·5°F–102°F.

(ii) Aerial respiration as normally performed by the fish from time to time: The fish makes a serpentine movement, goes to the top of the aquarium, raises its head about 1 to 2½ inches above the surface of water, opens its mouth widely and sucks up the air quite energetically—in doing so it produces a hissing sound. The opercular chambers swell up at once like two little balloons with air on either side of the head, thus giving the latter a characteristic pear-shaped appearance. The mouth may remain opened for some time (20–41 seconds) and is then closed, and immediately afterwards 5–8 small bubbles of the used-up air escape from the gill-openings, sometimes simultaneously from both the openings, or (less frequently) alternately from the right and the left one. So long as the mouth remains opened, evidently it does mouth-æration. Sometimes immediately after the air is gulped in and the opercular chambers are bulged out, the fish closes its mouth, withdraws itself in water with the swollen up, pear-shaped head, and after 2–5 minutes it gives off 3-4 larger bubbles from the mouth, and at the same time one or two smaller ones from the gill-openings also. After all the used-up air escapes from the opercular chambers the fish again rises to the surface of water and repeats this mode of aerial respiration. The branchiostegal membrane is small, very thin and semi-transparent, and firmly closes against the small gill-opening, so that when the opercular chambers are bulged out with air, each membrane lies within a definite constricted area, so to say, immediately behind the head—thus the latter becomes sharply demarcated from the rest of the body. Mouth-aeration is also very significant in this fish, which thus partly aids in aerial respiration.

Fr. Day (*Journ. Linn. Soc. Zool.*, XIII, p. 202, 1878) and Hora (1935) have casually mentioned about the gill-chambers of this eel being used for the purpose of breathing air.

(*a*) *Asphyxiation.*—When these eels are kept in a large volume of water under a diaphragm, at first their branchial respiration accelerates for some time (during 5-6 hours), then gradually it falls down, and ultimately the fish is asphyxiated—period for complete asphyxiation varying from about 10 hours to 38½ hours. With each experiment control fishes have been kept going, side by side, under identical conditions *without* the diaphragm. Like all other air-breathing fishes the eel struggles hard against the diaphragm, often with its tail, moves up and down in a frantic mood, makes convulsive movements, rolls down and briskly twists about, and then ultimately it loses its balance and drops down to the bottom. It may gasp for a minute or two with widely open mouth before succumbing.

(*b*) Semi- and almost -completely-asphyxiated fishes have been revived within 15 to 25 minutes after treating them with oxygen.

(*c*) Effects of removal of the opercula, CO_2 gas, and exposure to dry atmosphere on the respiratory activities of the fish have been studied in detail.

14. On a collection of elasmobranch embryos obtained from the Madras coast.

R. Gopala Aiyar *and* (Miss) G. Mahadevan, Madras.

The paper deals with stages of embryos of species of *Scoliodon sorrakowah*, *S. palasorrah*, *S. dussumieri*, *S. walbeemi*, *Hemigaleus balfouri*, *Rhinobatus granulatus*, *R. thouini*, *Paristis cuspidatus*, *Narcine timlei*, *Narcine indica and Astrape dipterygia*. In each case the description of the embryo, of the yolk sac, and of the placental connection, if any, with the uterine walls is given. An attempt is made to determine the breeding period of these viviparous elasmobranchs.

15. On the food and the spawning season of *Sardinella brachysoma* (Bleek.).

V. John, Madras.

Sardinella brachysoma is a sardine belonging to a genus of wide distribution. It occurs in the seas of India, Malaya Archipelago, Java, Borneo, Sumatra, Banka, Amboina—Australia, China and East coast of Africa. On the West Coast of the Madras Presidency large quantities of this fish are caught during certain years.

Food.—It is a pure plankton feeder, living on *Fragilaria coscinodiscus, Copepods, Nauplius larvæ, Larval prawns, Peridinians, Larval bivalves, Larval gastropods, Pleurosigma* and fish eggs.

Spawning season.—The development of the roe of this fish was very carefully watched with a view to determining the spawning season of the fish. This research is based on the examination of the roe of 463 specimens from April 1937 to April 1938. The conclusion to which the research points to, is that the fish spawns during May and June. This fish seeks coastal waters for spawning and the spawning season synchronizes with the commencement of the south-west monsoon. This paper has determined the season when the eggs and larval stages of the fish can be expected in the plankton for further study.

16. On the development of the vertebral column of *Lepidosteus osseus*.

H. K. Mookerjee *and* (Mrs.) S. Das, Calcutta.

Previous workers are of opinion that the arches play an important rôle in the formation of the vertebral centrum. The formation of the opisthocoelous joint has not been explained by them. The limit of the neural as well as of hæmal arches have not been determined by them. According to the previous workers the situation of the dorsal ligament is above the limit of the neural arch and not within it. The structures, such as supra basidorsal, supra dorsal and supra interdorsal have not been clearly defined. In the tail vertebra the ribs of either side fuse into a median part which protects the ventral blood vessels. All these have been clearly explained by the present authors.

17. Fishes of Karachi.

Nazir Ahmad, Lahore.

The paper deals with the systematic account of twelve species, selected out of huge collection of marine fishes, which the author made in December, 1934. Of the twelve species, ten belong to the order Acanthopterygii and two are referable to the order Plectognathii.

18. On the so-called pyloric cæca in a marine fish, *Trichiurus savala*, Cuv. and Val.

M. Rahimullah, Hyderabad (Deccan).

The structure and disposition of the cæca have been investigated by the author in this fish which is very commonly found round about the Madras coast during the months of September to January. In Madras it is usually called 'ribbon-fish' or 'dawali', and is said to be rich in phosphorus.

There are 32–36 cæca, arranged in the form of a whorl round the pylorus, and extending on the ventral side of the stomach. The cæca are arranged in double rows more or less crowded together, but their openings are quite independent and separate. The liver is partly covered over by the cæca as also the anterior part of the stomach. The stomach is a long, conical structure, with a tapering end. The intestine has only one loop which is anterior in position.

The blood- and nerve-supplies of the cæca have been fully described. The histological details have also been dealt with.

19. The food of the Mountain Barbel *Oreinus* McClelland, and its probable bearing on the introduction of brown trout in Himalayan streams.

GHULAM MUSTAFA MALIK, Kashmir State.

Attention is directed to Mitchell's observations regarding the destruction of the Mountain Barbels of the genus *Oreinus* from the Kashmir trout-streams and its consequence on the ecological conditions of the streams in relation to the growth of Brown Trout. The feeding habits and food of *Oreinus* are described, and an analysis of the gut contents of 131 specimens of *Oreinus* from Chitral, Kagan Subdivision of the Hazara District, and Afghanistan is given. It is concluded that Brown Trout, a carnivorous fish, flourishes well in association with *Oreinus*, as the latter keeps the streams clean of the vegetable growth and other deleterious matter and thereby encourages the growth of insect larvæ that inhabit rocks and stones and form the food of Brown Trout. Further, its fry provides food for the trout during the season when insects which form its normal diet are scarce.

No definite data are available about the food of Rainbow Trout in Himalayan waters, and it is therefore difficult to assess its influence on the indigenous fish-fauna of the streams of this area.

In view of the above a plea is made for a thorough biological investigation of the local waters before any exotic species are introduced.

20. On the urino-genital and Müllerian ducts in the male of the common Indian toad *Bufo melanostictus*.

J. L. BHADURI *and* A. K. BANERJI, Calcutta.

It is well-known in Salientian anatomy that the Wölffian ducts open separately into the cloaca. In the male of the common Indian toad *Bufo melanostictus*, however, these ducts unite before they open into the cloaca by a single aperture. This was first pointed out by Koch as an exceptional case in *B. melanostictus*. But it is now found by the authors that it is of general occurrence in this species.

The Müllerian ducts which occur in most male Amphibians are well represented in *Bufo*. It is not clearly mentioned for any species whether they open into the cloaca or not. The authors have found them to end blindly on the cloacal wall of this toad.

21. Some aspects of the chondrocranium of the tadpoles of *Rana afghana* and *Megophrys*.

L. S. RAMASWAMI, Bangalore.

In the tadpoles of *Rana afghana*, the development of long and thick cornua trabeculæ, the large rostral and Meckel's cartilages are correlated with a life in torrential waters and there is also a pseudobasal connexion. The quadratocranial commissure and the ligamentary quadratoethmoidal connexion are normally disposed. A tabular statement of comparision between the chondrocranium of the two legged tadpole of the 'Cystignathid' tadpole (Ramaswami, *in press*) and of *Rana afghana* is appended. In the case of premetamorphic stages of *Megophrys parva* and *M. robusta*, the quadratocranial commissure is present in early stages while in the metamorphosing *M. robusta*, it has broken down. In these tadpoles, the pterygoquadrate possesses an infundibular and a ventral process. There is no palatine artery in these forms and therefore there is no craniopalatine foramen. A subethmoidal cartilage is noticed only in stage B. of *M. parva*. An oticus connexion is wanting in the examined species of

Megophrys. An operculum makes its appearance in the metamorphosing stage of *Megophrys.*

22. The hyo-laryngeal apparatus of *Megophrys major* Blgr.

L. S. Ramaswami, Bangalore.

Trewavas describes the hyo-laryngeal apparatus of a female specimen of *Megophrys robusta* where the cricoid gives rise to two œsophageal processes which do not fuse posteriorly; in both sexes of *Megophrys major* examined by me, the hyoid and its musculature closely resembles that described for *Megophrys robusta,* but the larynx while agreeing with *M. robusta* in its musculature, shows a difference in the cartilaginous structure. The cricoid gives rise to two œsophageal processes which fuse in M. major to form a 'secondary' annulus in both sexes.

23. The chromosomes of *Uraeotyphlus menoni* (Annandale).

B. R. Seshachar, Bangalore.

A study of the spermatogenesis of *Uraeotyphlus menoni* (Apoda: Amphibia) reveals 36 chromosomes in the spermatogonia of this animal. Of these 16 are V-shaped and 20 are dots and rods. The former occupy the periphery of the metaphase plate while the latter occur in the centre. The primary spermatocytes show 18 tetrads of which three are atelomitic compound ring tetrads formed by six of the large V-shaped chromosomes of the spermatogonium. The rest are simple tetrads of which some are telomitic and others atelomitic.

24. On the occurrence and production of abnormal spermatozoa in the pigeon.

A. B. Misra *and* S. N. Mehrotra, Benares.

Abnormal spermatogenesis occurs side by side with the normal one within the same tubule. Abnormality sets in mostly at the spermatocyte stage by reason of irregularity in mitosis due to the incompatibility of the chromosomes. The abnormal behaviour of chromatin material alone, during mitosis, is responsible for the production of abnormal sperms of several kinds, *viz.* (1) giant sperms, (2) double headed, (3) hydra-headed sperms. The arrangement and disposition of chromatin in the development of these four types of abnormal spermatozoa is different from that seen in the case of normal spermatogenesis. Secondary spermatocytes give rise to giant spermatozoa by omitting the reduction division. Full details are given. Sometimes two spermatids fuse together and thus a giant sperm is produced. At other times, their partial fusion yields a double-headed sperm. Twin sperms have also been noticed but their approximation, at best, seems to be a temporary one. Sometimes two spermatocytes fuse together, and a giant one results. This process may be repeated more than once when a cellular matrix bearing several nuclei is formed.

Mitochondria and Golgi bodies do not show any peculiarity, at any stage, in the process of spermatogenesis, and they do not take any part in causing abnormal spermatogenesis to occur.

25. Morphology of the ossicula auditus in the hedgehog (*Erinaceous collaris*) and the house-shrew (*Crocidura caerulea*).

K. L. Malhotra, Benares.

The author has worked out detailed morphology of the auditory ossicles in the hedgehog and the house-shrew and has compared them with those of other mammals, especially the Insectivores. These bones present great variations excepting that the malleus is fairly laminated and the processus gracilis is like that of Marsupials. The malleus, therefore, is of a low type, but in *E. collaris* it is more specialized.

The processus brevis of the incus, when compared with the smallness of the bones, is well developed in *E. collaris*, but is poorly developed in *C. caerulea.*

The stapes has a true stirrup-like form in each case with slender unsymmetrical crura enclosing a wide intercrural aperture.

Many other important characters have been described and figured.

Entomology

26. Records of some insects from a hot spring in the Kulu Valley, Punjab.

H. S. Pruthi, New Delhi.

Certain Protozoa, Nematoda, Arthropods and molluscs among the invertebrate, and fishes, Amphibia and Reptilia among the vertebrate animals are known to inhabit hot springs in various parts of the world. Most of the thermophilous animals belong to the group Insecta. There are very few records of thermophilous insects or other animals from India.

In June 1938 when the writer was touring in the Kulu Valley, Punjab, he came across a small hot spring near Manali (6,000 ft.) the temperature of which was 45°C at 8 A.M. The spring was examined for animal life and only two species of Hydrophilid beetles were discovered. The beetles are *Helochares (Hydrobaticus) lentus* Sharp and *Coelostoma* sp. near *stultum* Walk. A sample of water was brought to New Delhi where it was chemically analysed. The records are of especial interest as Brues who has made an extensive study of the fauna of North American hot springs recorded only two species inhabiting water having temperature between 45-46°C. The great majority of animals were found below 40°C. It may also be added that the upper temperature limit compatible with aquatic animal life is about 50°C.

27. Sex ratios of the desert locust, *Schistocerca gregaria* Forsk. in the solitary phase along the Baluchistan Coast during the years 1932–1937.

M. L. Roonwal, Karachi.

A study of the sex ratios (as expressed in the percentages of males) of *Schistocerca gregaria*, phase *solitaria*, along the Baluchistan Coast has revealed that the mean male percentage falls *regularly* from about 59·4 to 48·0 *as we proceed from west towards east.* The figures for the four areas or Circles from west to east are as follows:—Gwadar Circle 59·4%; Pasni Circle 58·5%; Ormara Circle 54·8%; Ambagh Circle 48·0%.

The significance of this *regular* decline from west to east is not clear, but it may possibly be connected with climatic factors since the western Circles lie in the winter rainfall area, while the most eastern or Ambagh Circle lies in the summer rainfall area. The Ormara Circle, in point of view of sex ratios, its geographical position and of its rainfall period, occupies an intermediate position.

28. Some notes on eyestripes in Acrididæ.

Y. Ramchandra Rao *and* R. L. Gupta, Karachi.

Stripes in the compound eyes of various species of Acrididæ have been noticed by workers, but little significance has generally been attached to this character.

Dr. Roonwal first noticed the existence of two types of individuals among the solitary population of the desert locust in Mekran one with 6 and the other with 7 eyestripes.

Later observations have shown that the number of stripes in the eyes of the adult corresponds with the number of moults passed through in the hopper stage.

In the desert locust, most of the individuals collected from swarms show only 6 eyestripes, whereas both six and seven striped forms are to be seen in the *solitaria* population, and sometimes seven striped forms predominate. The eyestripes would thus appear to be of some significance from the point of view of phase.

Eyestripes are seen also in certain genera such as *Patanga, Nomadacris* and *Colemania,* where the number of stripes appear to correspond with the number of moults recorded for these insects.

In certain genera, stripes are not seen, being replaced by a marbled pattern as in *Locusta migratoria,* and in others, stripes are very indistinct except anteriorly, as in *Hieroglyphus* and *Oxya,* etc.

29. A neuro-muscular study of the mouth-parts of *Coccinella septempunctata* with a comparison of the mouth-parts in some Indian Coccinellids.

S. Pradhan, Lucknow.

This paper embodies:—

1. A description of the chitinous structures of the mouth-parts of *C. septempunctata.*
2. A description of both the extrinsic and the intrinsic musculature of the mouth-parts of the same species, with functions of the muscles in each case.
3. A description of the nervous supply of the mouth-parts of the same species.
4. A comparison of the chitinous structures of the mouth-parts in seven species of Coccinellidæ.
5. A short description of the sense-organs situated on the mouth-parts.

These studies have brought to light some facts of morphological importance. Thus, for example, the muscles of the designations of *Extensor of Lacinia, Cranial Flexor of Sub-galea,* and *Stipital Flexor of Sub-galea* do not exist in literature, the first two being recorded but differently interpreted, while the last one being not recorded at all.

The study of the nervous supply has revealed prominent aggregations of sensory cells in the labial and maxillary palpi and the galea. These sensory organs appear to be olfactory in nature. Thus these findings fill up the gap left by McIndoo (1916) in his study of the olfactory sense-organs in several parts of the body of Coleoptera. McIndoo searched for these organs in several parts of the body of Coleoptera (including (Coccinellidæ) but omitted to examine the mouth-parts where they are best developed in Coccinellidæ at least.

30. Glands in the head-capsule of Coccinellid beetles with a discussion on some aspects of gnathal glands.

S. Pradhan, Lucknow.

This paper incorporates a series of findings on the glandular structures present in the head-capsule of Coccinellid beetles. The glands have been classified in two ways:—

(A) *On the basis of structure.*

1. Multicellular complex acinose glands, 2. Multicellular simple tubular glands, 3. Unicellular glands.

(B) *On the basis of distribution.*

1. General hypodermal glands, 2. Ocular glands, 3. Antennal glands, 4. Intra-mandibular glands, 5. Mandibular, 6. Mandibulo-maxillary glands (Maxillular?), 7. Maxillary glands, 8. Intra-cardonal glands, 9. Labial glands, 10. Labral glands.

All these glands are being described for the first time in the family Coccinellidæ, some for the first time in the insect-organization as a whole. At any rate the co-occurrence of all these glands has never been described before.

The paper also includes a short discussion on the following aspects:—

1. *Actual openings of glands*, pointing out that some of the glands associated with the mouth-parts actually open outside the extra-oral cavity.
2. *Probable functions of the glands*, appreciating (*a*) a regular gradation from the unicellular to multicellular glands, (*b*) an identity between the unicellular glands described here and the hypodermal glands of McIndoo, responsible for defensive 'reflex-bleeding', and (*c*) that probably these glands are *neither* digestive, as the gnathal glands are generally supposed to be, *nor* defensive as the glands of McIndoo, but offensive and meant for paralysing the prey.
3. *The homology of the gnathal glands*, pointing out the difficulties in assigning segmental significance to gnathal, the chief difficulties being, (*a*) the presence of three pairs of tubular glands between the bases of the mandibles and the maxillæ, and (*b*) a regular gradation between the unicellular hypodermal glands and the complex labial glands.

31. Life-history of *Pterochlorus persicae* (peach-stem aphid).

A. S. Talwar, Lahore.

The outstanding feature of the life-history of *Pterochlorus persicae*, as in other aphids, is its extraordinary fecundity. The eggs are laid in clusters by sexual females during autumn. In March, with the flowering of the peach, the eggs hatch and give rise to wingless viviparous females. These reproduce parthenogenetically another generation of similar forms, among which a few winged forms also occur. A number of generations continue to be produced parthenogenetically for some time, and winged viviparous females become common. In June and July, however, their numbers are considerably reduced, and the author had to search a good deal before finding an isolated group of a few individuals.

Finally in the end of September or in the beginning of October their progeny produces sexual males and females. These pair, and the females lay fertilized eggs, which wintering on the peach plant repeat the cycle.

32. The life-history and morphology of *Euderus livida* (Ashmead) a larval parasite of the tur-pod fly, *Agromyza obtusa*.

Taskhir Ahmad, New Delhi.

This species originally described from America in 1894, is an important parasite of the Coffee leaf-miner, *Leucoptera coffeella* Guer. in Porto Rico (U.S.A.). It has been here bred from the larvæ of *Agromyza obtusa* infesting tur-pods at Pusa (Bihar), Karnal (Punjab) and Delhi. There is considerable variation in the size and colour of the adults, *e.g.*, the length of the male varies from 1·45 mm. to 2·25 mm., that of the female from 2·25 mm. to 3·25 mm.

The life-history is described for the first time and various stages are illustrated. The female lays one to four eggs on the body of a single host inside the tur-pod. The preimaginal stages require for their development 10–12 days at 27°C, 16–18 days at 22°C and 40–43 days at 17°C.

33. Some new parasitic Hymenoptera from India.

K. B. LAL, New Delhi.

Descriptions and figures are given of new species of *Apanteles*, *Stenobracon*, *Iphiaulax* (Braconidæ), *Psenulus* (Sphecidæ), *Paradryinus* and *Goniozus* (Bethylidæ), all of which, except *Iphiaulax* sp., are associated with insect pests of sugarcane in India.

34. Growth and respiration in the galls of *Asphondylia riveae* Mani and *Odinadiplosis odinae* Mani (Itonididæ: Diptera).

M. S. MANI, New Delhi.

It is known that the enzymatic secretions of the larvæ of gall insects, by rendering the contents of the plant cells soluble, bring about an abnormal increase of available food material in a limited area of the plant tissue. The consequent increased physiological activity, which results in gall formation, as measured by the rates of growth and respiration, is found to be closely correlated with the development of the midge larvæ and when pupation of the midge begins disappears altogether. The development of the midges and the rates of growth and respiration in the galls throughout the life-cycle were studied in two species of gall midges *Asphondylia riveae* Mani and *Odinadiplosis odinae* Mani. The rate of growth in the galls was measured by the volumetric method and the rate of respiration by determining the volume of carbon dioxide expired by 100 c.c. of the gall in one hour, using galls *in situ* on pot-grown plants. Control experiments with normal plant-parts were also made. Data presented show that galls grow only during the larval stage of the midges but stop growing when pupation begins. The rates of growth and respiration are at first low but as the larvæ develop they increase and reach a maximum before pupation, after which there is a rapid decline. The rates in the galls are comparable to those for young plant parts, though the galls are found forming on old parts.

35. On a new Trombidiid larva parasitic on the house rat (*Rattus rattus* var.).

M. ABDUSSALAM, Lahore.

Trombidiid larvæ have not attracted the same attention in India as in some other countries in the East, apparently because they have not been seriously incriminated as transmitters of tropical typhus in this country. Only about seven species are known, all described by two workers—Hirst and Ewing who had occasionally received stray collections from India.

A few specimens of the form described in the present paper were found in the external ear of a house rat caught at Mukteswar (Kumaun hills, U.P.). Details of its morphology and systematic position have been discussed in the paper and it has been named as *Gahrliepia homunguis*, sp.n. Validity of the closely allied genus *Schöngastiella* Hirst has also been discussed.

36. Practicability of biological control in the lac industry.

P. M. Glover, Namkum (Ranchi).

The average annual production of stick lac in India is approximately 10 lakhs of maunds. To this must be added roughly 50–80 thousand maunds being the production of Assam and Burma.

Damage to the lac crop is of two kinds: Damage due to causes *other than insects* accounts for no less than 30–40% of the original settlement. Insects are responsible for a further 30–40% damage. Insect damage is caused by two classes of insect enemies. Parasites destroy an average of about 5% of the cells only; Predators destroy roughly 30–35%. Predator damage is caused almost exclusively by the larvæ of *Eublemma amabilis* and *Holcocera pulverea*.

Biological control of lac parasites is not practicable. As the damage done by parasites is only small, this is of minor importance. An investigation of the parasites of the predators has shown two species to be of major importance.

Microbracon greeni is an indigenous ecto-parasite of the larvæ of *E. amabilis*; the percentage parasitism is at present only 10–15%. but results indicate that liberation of laboratory bred adults at critical periods would increase this figure considerably.

Microbracon hebetor is an ecto-parasite of the larvæ of both *E. amabilis* and *H. pulverea*, and is an introduced species not occurring in the major lac growing areas. Laboratory experiment indicates promising results from the large scale liberations of this species.

Field work on these two species is being taken up this year.

The recent discovery of two egg parasites of *E. amabilis* and *H. pulverea* eggs, identified as *Trichogramma minutum* and *Trichgrammatoidea nana* may have far reaching effects.

37. The economic importance of *Microbracon greeni* Ash an ecto-parasite of *Eublemma amabilis*, the major predator of *Laccifer lacca*, lac.

S. N. Gupta *and* P. M. Glover, Namkum (Ranchi).

Microbracon greeni Ash is an ecto-parasite of the larva of *Eublemma amabilis* Moore which is a cosmopolitan predator of *Laccifer lacca* Kerr, damaging from 20 to 25% of the lac cells. *M. greeni* is monophagus in the field, and can easily be bred in the laboratory on *E. amabilis*. It can also be artificially bred on several alternative hosts under laboratory conditions, the more important of which are *Platyedra gossypiella*, the pink boll worm of cotton and *Etiella zinkenella*, a *Pyralid* on garden peas.

The *Braconid* has 20 generations per year as compared with the host's 5 generations; the minimum life-history period, in summer, was 12 days and the maximum, in winter, 41 days. The percentage of females in the progeny averages 65%. The average fertility per female population (30% are sterile) is 17 with a capacity of 3·5 eggs per day. During a life time, an average of 10·5 hosts are parasitized; the average number of eggs per host is 2·6, the average number of adults bred per host is 1·95, and the effective rate of breeding is 70–75%. The average annual longevities of males and females are 13·5 and 18·2 days respectively.

M. greeni is an indigenous cosmopolitan parasite, the percentage parasitism lying between 10% and 15% only. The indications are that periodic liberations of laboratory bred adults at critical periods, which would appear to be March-April, June, August and October–December, would increase the percentage parasitism considerably. Field work is being taken up this year, and liberations will be made under controlled conditions in a specially chosen area, and it is believed that the results obtained will confirm those obtained in the laboratory.

38. What is the correct taxonomic status of *Monophlebus quadricaudatus* Green.

S. Rammohan Rao, Benares.

The occurrence of *Monophlebus quadricaudatus* in India is reported for the first time. Full descriptions of the adult male and the female have been given, and Green's description has been slightly emended in the light of the new facts gathered. Curiously enough this species occurs in localities (Ceylon and Benares) separated by thousands of miles of territory and it is hoped that a search for it would reveal its presence in other localities also. In the light of Morrison's work, it seems that *M. quadricaudatus* Green is really referable to the genus *Drosichiella* (*Morrison*) on account of the presence of multiocular pores within the atrium of the abdominal spiracles. Thanks are due to Dr. A. B. Misra under whose supervision this work was done in the Hindu University Laboratory.

39. On the secretion of the ovisac by the female of *Drosichiella* (*Monophlebus*) *quadricaudatus* and its structure.

A. B. Misra, Benares.

The females of *Drosichiella* (*Monophlebus*) *quadricaudatus* secrete the cottony ovisac from the ventral abdominal segments four months after insemination by the males. The thorax and the dorsal part of the abdominal segments (terga) are not concerned in producing the ovisac. When the female begins to oviposit, the glands occurring on the dorsum tend to degenerate. Several kinds of multicellular glands occur in the hypodermis of the ventrum in the abdominal region. Their structure and distribution has been fully described. The ovisac of *Drosichiella quadricaudatus* is made up of five sheets of waxy threads and a waxy tube containing the eggs.

The waxy filaments produced by each segment run together closely to form a sheet of waxy consistency. Four such sheets are formed in front of the genital aperture. The circumgenital glands secrete the waxy tube in which the eggs are contained, whilst the penultimate segment produces the sheet of waxy threads which lies over all the rest of them.

Vaginal glands have also been found to be present in this case. These *probably* secrete some substance which makes the eggs glossy or shiny in appearance during their escape to the exterior through the vagina.

40. On the internal anatomy of the first stage larva of *Drosichiella* (*Monophlebus*) *quadricaudatus*.

S. Rammohan Rao, Benares.

Two types of glands occur under the integument which consists of an external cuticle beset with numerous pores, spines and setæ and an underlying layer of hypodermis. Ventral gland is present in the larva behind the genital opening, but it is unconcerned with the secretion of the ovisac. The structure of the nervous, digestive and respiratory systems and of other organs have been described in full, and a channel comparable to the dorsal vessel is presumed to have been detected in the larva of this species. Corpora albata and gustatory organs have also been found to be present in this case.

The author is indebted to Dr. A. B. Misra for many useful suggestions and guidance.

41. Damage to wheat, sugar-cane, maize and fruit trees by termites in the Punjab.

M. S. Sarwar, Lahore.

This paper deals with the damage done by termites to wheat, sugarcane, maize and fruit trees in some districts of the Punjab. Various species of the genus *Odontotermes* are responsible for the damage. The different ways of attack by the termites and the resultant loss in percentage has been recorded.

42. New species of termites recorded in the Punjab.

M. S. Sarwar, Lahore.

In this paper the author gives a systematic account of four species and two varieties of termites collected and identified by him. Of the four species three belong to the genus *Odontotermes* and one belongs to the genus *Microtermes*. Both varieties belong to the genus *Odontotermes*.

43. Taxonomic value of the structure of mandibles of workers in termites.

M. S. Sarwar, Lahore.

In this paper an attempt has been made to differentiate workers of one species from those of the other on the basis of differences in the structure of their mandibles. As a rule the differences between the mandibles of various species are negligible, but they are well marked in *Odontotermes*, *Microtermes* and *Leucotermes*.

44. New sub-genus of the genus *Microtermes*.

M. S. Sarwar, Lahore.

In this paper the author gives an account of the sub-genus *Microdontermes*, which has been created by him to replace a newly recorded species, *Microtermes mukarensis*. This species combines in it the characters of two genera, *viz.*, *Odontotermes* and *Microtermes*. In the structure of the mandibles of the soldiers it resembles *Odontotermes*; while the structure of the head and thorax is comparable with that of *Microtermes*.

45. New wood-destroying species of termites in the Punjab.

M. S. Sarwar, Lahore.

This paper deals with the systematic position and habits of *Odontotermes giganticus* sp. n. and *Odontotermes domesticus* sp. n. Both species destroy wood, and were collected by the author from various parts of the Punjab.

They attack wood after the fashion of *Odontotermes feæ*, but differ from it in keeping the outer-most covering intact. Their attacks are restricted to the hard portion of the wood.

46. Effect of temperature and humidity on cocoon production of silk-worm, *Bombyx mori* L.

D. C. Sarcar, Calcutta.

Experiments are being conducted on the effect of temperature and humidity on cocoon formation and to find out the optimum temperature to get the maximum yield of silk without sacrificing the quality. The experiments are first made by rearing the larvæ in different seasons with record of maximum and minimum temperature and humidity. From the reading of such data the advantageous temperature and humidity were found out, and the larvæ were reared inside electric incubator with automatic arrangements for varying temperature and humidity. The experiments were carried out with Nistid II lot, Nismo, and Nistid IV lot. It is found that in November and December the maximum yield is obtained with minimum temperature (59F). and humidity (50%).

47. Effect of variable temperature and humidity upon different varieties of silk-worm.

D. P. Raichoudhury *and* S. B. Pal, Calcutta.

Different varieties of silk-worms were reared under electric incubator of controlled variable temperatures and humidities. Comparative study of life-histories, qualities of cocoon and yield of silk, etc. were made.

48. On the mouth-parts of the silk-worm, *Bombyx mori* L.

D. P. Raichoudhury *and* H. L. Sarkar, Calcutta.

The development of the mouth-parts has been traced from the egg stage right up to the adult moth. In the entire larval period there is hardly a structural change in the mouth-parts, except their mere growth in the successive instars.

49. On the reproductive system of the silk-worm, *Bombyx mori* L.

D. Mukerji *and* S. B. Pal, Calcutta.

In this paper the reproductive system of both the male and female moth is described. The development of the genital glands and their ducts is traced from the larval to the mature stage. The histology of the ducts and the accessory glands is inquired with special reference to the function of bursa and seminal duct. The mechanism of copulation is studied.

50. Experiments on the repeated pairings of *Bombyx mori* L.

D. P. Raichoudhury *and* S. P. Mookerjee, Calcutta.

This experiment mainly relates to the production of viable and non-viable eggs in silk-moths. At first newly emerged unused males and females were paired. Later on used males were paired with virgin females.

51. On the nervous system of silk-worm, *Bombyx mori* L.

S. B. Pal *and* H. L. Sarkar, Calcutta.

Dissections were made in the different larval stages of silk-worm with a view to studying the distribution of nerve fibres in the different parts of the larvæ.

52. On the differentiation of sex in the first stage larva of *Drosichiella* (*Monophlebus*) *quadricaudatus*.

S. Rammohan Rao, Benares.

All the *early* first stage larvæ of *Drosichiella* (*Monophlebus*) *quadricaudatus* are alike there being no morphological difference on the basis of which the sexes could be distinguished. A change in the colour of the *late* first stage larvæ has been detected and it has been found that the male-producing larvæ are brick-red in colour, while the female-producing ones are yellow. This difference in colour persists throughout the subsequent stages in the development of this insect. The gonad in the *male-producing larvæ* appears in the latter part of the first stage in the form of an elongated solid cord of cells in which spermatogonia can be distinguished. The female gonad does not develop at the corresponding stage. Histological and cytological changes occurring in the male gonad have also been followed to establish the correct identity of it.

Thanks are due to Dr. A. B. Misra under whose supervision this work was carried out.

53. The life-history of the 'Stilt bug' *Metacanthus pulchellus* Dallas, with a note on the immature stages of Berytidæ (Neididæ)—Hemiptera—Heteroptera.

C. K. Samuel, Pusa.

The members of Berytidæ (Neididæ) are popularly called 'Stilt bugs'. *Metacanthus pulchellus* Dallas is a species of sub-family Metacanthinæ.

The life-history of this species has not been recorded so far. It occurs at Pusa in all its various stages on bottle gourd and pumpkin plants in association with the tobacco capsids (*Engytatus tenuis*). Single translucent white eggs are laid on the lower surfaces of the leaves. Ten to fifteen eggs were laid by a single female in May, and 6 to 10 in January. The incubation period was 3 to 4 days in May, and 5 to 12 days in January. The tiny young nymph is constricted into two main divisions, and clothed with globe-tipped hairs. It casts five moults and passes through five instars. The total nymphal period was 21 to 23 days in May and 24 to 30 days in January. The life cycle was 24 to 27 days in May and 29 to 40 days in January.

The longevity of adult bugs ranged from twenty to twenty-five days among males and twenty-two to twenty-eight days among females.

In the laboratory the bug completed eleven broods in the year from January 1935 to January 1936.

The male differs from the female in certain characters.

At the end of the season few plants should be left in the ground to serve as traps for the bugs. They can be killed by spraying with Crude Oil Emulsion or Fish Oil Soap. The trap plants may also be burnt wholesale in order to ensure complete destruction of the pest. The insect can also be starved by the complete removal of the crop soon after harvest.

A brief note on the immature stages of Berytidæ is added.

54. Bionomics of two coccinellids *Adonia variegata* Goez. and *Brumus suturalis* F. predating on aphids.

A. P. Kapur, New Delhi.

Adonia variegata Goez. is a palearctic species which also occurs in northern India and is exclusively aphidivorous. It is common from March to June and species of aphids on which it feeds are recorded in this paper. In the insectary the male beetle lives on an average for 28 days and the female for 34 days. The pre-oviposition period is 5 days and the egg-laying capacity of the female varies with the amount of food available. There are four larval instars and the preimaginal period varies from 9·7 to 15·8 days depending on temperature (32°C–25°C).

The average number of aphids (*Myzus persicae* (Sulz.)) fed in the first instar was 14, in the second instar 21, in the third 30 and in the fourth 64·5. The adults fed from 35 to 75 aphids a day, the female often consuming more than the male.

Brumus suturalis F. was bred on *Myzus persicae, Hyalopterus atriplicis* and *Pseudococcus* sp. infesting *Cynodon dactylon*. There are four instars with a preimaginal period of 18 days in the insectary. An adult beetle lives for 1 to 1½ months. The larvæ feed on the body contents of coccid and aphid nymphs by a process of alternate sucking and regurgitation.

Homalotylus flaminius (Dalman) was bred from larvæ and pupæ of *A. variegata* and *B. suturalis*. *Hyperteles* sp. was bred from pupæ of *A. variegata*.

Coloured plates illustrating the life-history of the coccinellids will be exhibited.

SECTION OF ANTHROPOLOGY

President:—D. N. MAJUMDAR, M.A., Ph.D., F.R.A.I.

Ethnology

1. Racial affinities of the Hindu population of Orissa.

A. K. MITRA *and* B. K. CHATTERJI, Calcutta.

In this paper the authors analyze the anthropometric data on the Brahmanas of Orissa and observation on their integumental characters taken by Dr. B. S. Guha, and compare them with Risley's data on other Orissan castes. Comparison is also made with the Brahmanas of Bihar, and conclusions drawn regarding the racial strains present in the Hindu population of Orissa.

2. Substratum of Mediterranean element among the tribes of Sind and Baluchistan.

C. R. ROY, Karachi.

Analysis of the anthropometric measurement of 100 Brahuis and 100 Sindhis. Nearly equal percentage of Irano-Mediterranean and Indo-Iranius elements are found among the both. The basis of the Brahuis is Mediterranean which has been modified by the Indo-Afghans on one hand and by Homo-Alpinus or Pamiri stock on the other hand. The basis of the Sindhis is also Mediterranean which has been modified by a strong Homo-Alpinus stock.

3. A plea for the reconsideration of the anatomical landmarks in craniometry.

R. N. BASU, Calcutta.

Some of the anatomical landmarks as prescribed by the Monaco Agreement are discussed. The difficulties in their location in some skulls are mentioned. The difficulties experienced in connection with some of the craniometrical measurements are also discussed.

4. Determination of the nasion in the living.

K. P. CHATTOPADHAY, Calcutta.

In this paper the author discusses the methods followed by previous workers in fixing this point. He criticizes certain recent suggestions in the light of measurements taken by him.

5. Studies on the hand-form of the Bengalis.

P. C. BISWAS, Calcutta.

The following study is based upon the investigations of 140 Bengali male hands (70 right and 70 left hands). For this study the following measurements are taken:—

(1) Length of the hand—length taken from the middle point of the line joining the stylion radiale to stylion ulnar to the Dactylion point.

(2) Breadths of the hand are taken in three different places:—

(*a*) breadth from Metacarpale radiale to Metacarpale ulnar;
(*b*) breadth from Proxindicion to Ulnoquintion;
(*c*) breadth from Distindicion to Ulnoquartion.

The characteristics of the hand-form is determined from a number of indices. The hand-form of the Bengalis is then compared with that of the Swedish and Issa-Somali.

6. The Pterion in Indian human crania.

R. N. Basu *and* M. N. Basu, Calcutta.

A few skulls collected in Bengal, the diaptographing tracing were taken in all the skulls of the Pterion regions—the results tabulated and compared with other published results.

Ethnography

7. Indian Basketry—their texture and design.

B. S. Guha, Calcutta.

A comparative study of the texture and designs of Indian Basketry based on the specimens in the collection of the Indian Museum is made in this paper.

8. The Vaghers of Okhamandal.

S. T. Moses, Baroda.

Introduction—The caste and its traditional origin (*a*) from the sweat of God, (*b*) from the hole where Kashasura was destroyed, and (*c*) from the sweat of Krishna, to punish Arjuna. Really they are the aboriginal Kshatryas with a mixture of Rajput races. The name Vagher and its derivations (*a*) uncomplimentary name because of tiger-like characteristics, and (*b*) cooled a God when on a visit to hot Okha and so got the name. Occupations—Fishing, pearlfishing, piracy and outlawry, agriculture and as coolies, cartmen and guides—Salami tenure in Agriculture—Waterdivining and posthumous children—Their food, drink, etc.—Dress—Games and entertainments—Speech—Religion—Marriage, divorce, etc.—Characteristics—Cranial and nasal measurements.

9. Some aspects of the material economy of Transgiri people.

Y. S. Parmar, Lucknow.

The Transgiri territory lies in the small hill State, called Sirmur, very often known as Nahan because of the capital. The State of Sirmur lies among the outer Himalayan ranges between 77° 5′ and 77° 55′E. and 30° 20′ and 31° 5′N. It is bounded on the north by the Simla hill State of Balsan and Jubbal, on the east by the Tons river, which divides it from the Dehradun District of U.P. from which the Jumna also separates on the south-east. On the south borders of the State of Kalsia and the Ambala District of the Punjab. It is bounded on the west by Patiala territory and on the north by Keonthal.

A detailed description of the occupations of the people of this area, their general economic conditions, the state of communications and the interdependence of the various cultural groups is given. Ethnographic details about dress, decoration, ornaments, utensils, weapons, agricultural implements, fishing traps and nets, musical instruments, etc. are provided. The influence of cultural contacts on domestic and agrarian economy is illustrated.

10. Marital life in the Transgiri tract.

Y. S. Parmar, Lucknow.

The author gives a general account of the social life of the Transgiri people. He describes the different types of marriage, viz., Phera, Jhajra and Reet. The common form of marriage is Jhajra which is now being replaced by Phera. In Kullu Jhajra has come to indicate widow remarriage, but in the Transgiri tract it is the regular form of marriage. Reet is a form of marriage, without any ceremony whatsoever, contracted by paying a money price (varying according to the beauty of the girl, generally from Rs.100 to Rs.500 and in many cases goes to four figures even) to the guardian of the girl if she is unmarried or to the husband of that girl if married. There is no limit to Reet marriages as is evident from their nature, can be as easily dissolved as they are freely resorted to. The influence of Reet on the life of the inhabitants, not only of this tracts but other neighbouring hills has been estimated. It has deprived men of their morals and women of their chastity. It has adversely affected their economic life inasmuch as the people are incurring debts because of it. It has been responsible for quarrels and bitterness within the village and feuds between neighbouring villages. It has also resulted in the disintegration of family life and has led to instability of family organization. The various measures taken to eradicate the evils of Reet have been detailed: also the various forms of marriage, polygyny and polyandry are described and discussed.

11. Taboo and discipline of sex and family.

R. K. Mukerjee, Lucknow.

Sex taboos are social mechanisms devised with a view to limit the violent and exuberant outbursts of sex and regulate these along certain defined and legitimate channels. The institution of marriage both in savage and more advanced society is protected by taboos. Other taboos seek to limit the occasions of contact between the sexes and maintain the normal routine of social behaviour. The institution of a bachelor's house and unmarried girl's house, found among many primitive peoples, also often subserves the purpose of providing opportunities of courtship and marital apprenticeship and gradually undertakes the function of tribal schooling.

In the course of social development approved forms of sex conduct rather than negative injunctions play an important part in governing marital life and behaviour. Man's conduct is socialized through the gradual interlacing of his impulses and interests. In the family life in advanced society, taboos and laws are applied in very few cases for the prevention of sex transgressions, the reliance being chiefly on the attitudes which the social environment and family tradition inculcate. From magic and taboo to law and punishment, and from these latter to attitudes, moral and social,—this seems to be the normal development of means of sex discipline.

12. The 'Shaman' personality: a psychological evaluation.

N. N. Sengupta, Lucknow.

The Shaman exhibits in certain cases a marked change in the 'sex-personality'. In other cases there is evidence of catalepsy, manicdepressive psychosis and also of schizoid tendencies. The paper attempts on the basis of these data to formulate a psychological estimate of the Shaman personality.

13. Mental diseases among the primitive people.

N. N. SENGUPTA, Lucknow.

(1) The paper summarizes the available data on the frequency and special forms of mental diseases found among the primitive people of different regions of the globe.

(2) It concludes on the basis such facts that the cultural races are less susceptible to mental disorders in comparison to the primitive peoples.

(3) It attempts to formulate certain general conclusions concerning the differential social factors operative in the two cases, of the primitive and of the civilized peoples.

14. Totemism in Ancient India.

C. D. CHATTERJEE, Lucknow.

The history of totemism in Ancient India can be traced as far back as the time when the Aryans had settled in the Punjab and their eastward migration was about to commence (c. B.C. 1200). Unfortunately, the information preserved in the literary works of the Vedic and post-Vedic periods is so very meagre that it is not possible to form a clear idea of the social conditions of the totemic peoples of India in the remote past, or to give a detailed account of their influence on the Aryan culture and civilization. In this paper, an attempt has been made to trace the history of totemism from the time of the Aryan settlement up to about B.C. 200 on the basis of the material available in Sanskrit and Pali works.

It now appears to be a certainty that some influence of totemism can be traced in the Ṛgveda, the oldest literature of India, as will be seen from the data brought together in this paper. The influence becomes all the more marked in the later Vedic works as well as in the epics, the Rāmāyaṇa and the Mahābhārata, though none of them has preserved the name of a single totemistic clan. The present writer has been able to discover the names of some of those clans in Greek works relating to Ancient India as well as in Pali texts and commentaries composed at different periods. He has also shown how under an imperial order members of some totemistic clans left India and went to Ceylon where they finally settled down. The descendants of those migrants retained their respective totemic characters for many generations and at times figured in the history of that country. But they do not appear to have come into cultural contact with the Väddā community, the dolicho-platyrrhine jungle tribe of Ceylon.

15. The disposal of the dead among the primitive tribes of Travancore.

L. A. KRISHNA IYER, Travancore.

Burial and cremation are the two common methods of disposing of the dead bodies. Most of the primitive tribes of Travancore bury the dead. Burial has for its object the prevention of the ghosts from tormenting the living. The devices intended to prevent the return of malignant spirits are manifold. Among most of the tribes of Travancore, a stone is planted at the head and foot of the grave. Great care is taken for the toilet of the corpse. The dead body is washed, well dressed in new garments, for the dead must enter the spirit world in the best array. Great importance is attached for the proper disposal of the dead. The idea is that the dead would walk unless the dead body is disposed of with appropriate ceremony. If there is no propitiation, the restless spirit of the deceased will walk among them, bringing sickness, want, and ravages of wild animals. The dead are buried with all the paraphernalia which belonged to them in life. Everything belonging to the dead man was put out of sight and buried with him. All the tribes lead a pure life during the period of pollution and refrain from sexual intercourse, ordinary work, and amusements.

16. The cultural national outlook.

S. C. Roy, Ranchi.

Each people in the world has in course of ages evolved a unique culture of its own, through the combined influence of environment heredity, and varied contacts and social impressions. Different cultures have thus developed each its own cultural pattern, its unique racial genius, its own cardinal tone, its vital rhythm.

Through mutual contact and helpful exchange of cultural-traits and ideas, different cultures enrich each other. And this is how group cultures develop, and provincial cultures combine into a continental culture. A wider synthesis of different cultures is expected to produce a richer world-culture, without impairing the individuality of each particular sectional, regional or racial culture. It is these variations in sectional, regional, or racial cultures within a province or a continent that impart charm, reality, and fullness to human culture as a whole.

17. Notes on the different types of apparatus used for smoking '*Pancharang*'.

B. K. Chaudhuri, Calcutta.

In this note the author studies the various forms of apparatus used for smoking a particular kind of 'nesha' known as 'pancharang' (usually a blend of five kinds of 'neshas' or intoxications, viz., *Ganja*, *Guli*, *Charas*, *Siddhi*, *tobacco*). The apparatus are classified into two main groups, viz., (1) without water chamber, (2) with water chamber. The former one is a fire baked pottery work just like a 'chilam' used for smoking '*ganja*', with five small bowls. The latter is a complex one, and may be divided into two sub-groups, viz., (i) water chamber and the mixing chamber one and the same, (ii) separate mixing chamber and water chamber. The sub-group (ii) may again be classified into two types, viz., (*a*) single liquid chamber, (*b*) double liquid chamber. The later usually contains country liquor in one and ice water or rose water in the other. Bowls of the groups No. 2 are differently made, some are fixed with the composite bowl while the others are separable. In some cases the bowls are made perforated on which particles of '*ganja*' or '*charas*' are sprinkled and smoked. A detailed descriptions of the apparatus with photos and diagrams are given with a note on its distribution.

18. The Sun as a folk god.

Nanimadhab Chaudhuri, Calcutta.

Sun-worship has, broadly speaking, two aspects. In one aspect he is worshipped as the abstract source of light and life and in the other as a folk god connected with fertility and having bucolic attributes.

The folk aspect of sun-worship remarkably rich in the Ṛgveda, is connected with cattle, agriculture, marriage, fertility and cure of disease. In the post-Vedic literature the Sun as a folk god is more concerned with cure of disease and protection of cattle. The Sun as the guardian deity of herdsman is a completely individualized, anthropomorphic god in the Ṛgveda and this conception reappears in the later texts under new environments embodied in Gopāla-Kṛṣṇa. The Vedic tradition of the Sun as a cure god merges at a later period in a rich cult possibly substantially borrowed from foreign sources. The Sun god appears to have been worshipped in connection with agriculture as a rural deity in Bengal in the Middle ages and was identified with the Buddhist god Dharma probably under the same aspect of an agricultural deity. In Brahmanical society folk worship is offered to the Sun god for securing domestic happiness and offspring; in non-Brahmanical society, for good harvests and offspring.

There is evidence of the existence of folk worship of the Sun in other ancient lands from pre-historic times; in India apart from the purely tribal worship of the Sun there is an unbroken continuity of folk worship of the Sun from the early Ṛgvedic age up to the present time.

19. Dynamics of caste.

R. N. Saksena, Lucknow.

Since Risley's analysis of the processes of Caste formation about 40 years ago, no serious attempt has been made to study the processes of Caste formation. New castes are even now being formed as a result of fission. A difference of locality, adoption or abandonment of a degrading occupation, a change in social practices, or even increase of prosperity may lead to fission. Cases of fission due to change of locality are rare, since all such barriers have now been broken due to improved means of communication and transport. In some cases the adoption of degrading occupation by certain families has resulted in the social disaster of that group, compelling them to marry among themselves, and thus to form a separate sub-caste. Change in social practices also leads to the formation of new castes. Due to increased wealth and prosperity some castes are trying to rise in the social scale. The first thing they have done is to stop widow-remarriage and then they have tried to include themselves in the higher group. Changes in castes due to pollution including alleged low origin may be traced in some cases.

Finally, the author traces the stages through which primitive tribes, by giving up their animistic practices and beliefs, are being absorbed in the Hindu social system and forming separate castes.

20. Prehistoric rock carvings.

D. Sen, Calcutta.

The writer describes some prehistoric rock carvings on a series of erratic blocks near Campbellpore, Punjab, first noticed by the Yale Cambridge N. India Expedition in 1935. The writer in a recent tour has observed more of such erratics containing carvings of interesting designs.

21. A description of the Nicobarese rat-trap.

R. R. Mookerji, Calcutta.

The paper deals with a detailed description of the type of rat-trap used by the Nicobarese. Morphologically the trap bears a very close affinity to the traps used in Sumatra and Samoan Islands for the same purpose, giving an additional proof of the cultural connection of these regions.

22. The Kabadi system in Bastar State.

T. C. R. Menon, Bastar (C.P.).

The Kabadi system of Bastar by which an aboriginal, suddenly met by a demand for cash, takes a loan from a master, and repays it in the form of agricultural services, on remuneration has the tradition of centuries behind it. In Bastar, where the tenants cannot sell their holdings and where the personal belongings count for but a trifle, the average aboriginal cannot raise money unaided for such unavoidable expenses as that for a marriage where bride price has to be paid, or for compensation to the girl's maternal uncle or for such unexpected emergencies as a heavy fine, in a criminal or excise case. The Kabadi loan is a loan without security, the only kind that a moneyless aboriginal can raise. It helps him out in an emergency, and as such it is an institution which keeps up the stability and equilibrium of society. The various uses and abuses of the system have been detailed. How far the system differs from slavery or forced labour is explained. Remuneration of Kabadis, rules regarding residence, steps taken by the administration to wipe out the evils of the system and to end it generally are all fully discussed. Equivalents of the Kabadi system in other parts of the country are also described.

23. Effect of culture-contact on the Garos of Assam.

J. K. Bose, Calcutta.

The Garos are generally found in the Garo Hills, Assam, but some of them have migrated and settled in plains. In this paper the author discusses the Plains-Garos of Mymensingh, who came in contact with the neighbouring people of that place. As a result the Garos have imbibed the culture of the local people and have considerably modified their own culture. This change of culture from various aspects of their life is discussed in the paper.

24. Notes on a fish-gorge from Bengal.

T. C. Das, Calcutta.

Description of a type of fish-gorge of the spring variety, found by the author in Tippera District, Bengal. Distribution of the type in the East. Its prototype in the West. Distribution of the straight-gorge and its relation with the former variety. Antiquity of the straight-gorge in the West and the East. Probable origin of the Indian spring-gorge.

25. The Murias of Narayanpur, Bastar State.

Kr. Indrajit Singh *and* D. N. Majumdar, Lucknow.

The authors describe the social life of the Murias whom Grigson has called Jhoria Murias. The various customs which are indigenous to the tribe are elaborately described and the influence of contacts with the higher cultural groups of the State discussed.

26. Caste and credit in rural society.

R. N. Saksena, Lucknow.

The paper is a study of rural indebtedness as it affects the various castes in a particular locality. The creditors are reluctant to advance loans to the high castes in spite of the fact that they offer better security, because they have become notorious for lack of industry, and rather questionable honesty, and also for extravagance. On the other hand, some of the low castes, e.g. Chamar and Pasi, enjoy good credit due to the economic service they render to the community. Therefore, the status of the caste is not always an important factor in heightening the financial status of the caste.

But the high castes may have gained a bad name for their extravagance or even vice; they still get better terms of credit than the low castes, partly because of the better securities they can offer and partly because of their social status. In comparison to other castes, the Chamars and the Pasis are more prosperous, because they have two sources of income—land and labour—which supplement each other. The social causes such as huge expenditure at marraige, birth of child, etc., have helped to increase the indebtedness of the high castes. But the cause of the indebtedness of the low castes is primarily economic. The factors that have important bearing in caste indebtedness are detailed and discussed.

SECTION OF MEDICAL AND VETERINARY RESEARCH

President:—RAO BAHADUR T. S. TIRUMURTI, B.A., M.B. & C.M., D.T.M. & H., F.N.I.

A. MEDICAL RESEARCH

Medicine and Pathology

1. A preliminary report on the possible etiological factor in the causation of infantile biliary cirrhosis being found in castor oil.

T. S. TIRUMURTI *and* K. NARAYANA MURTHI, Madras.

I. Varieties of castor oil plant, influence of climate, varieties of seeds as regards their size, surface markings over the seed coat, their purgative value, the process of extraction of the oil and the chemical composition of the entire seed, including the oil is described.

II. History of administration of castor oil (Oleum Ricini) since birth was obtained in a large number of cases, which came under their observation. More than the therapeutic dose (60–120m) were used in all the cases. The authors found castor oil being extensively used in South India, which includes the Deccan plateau of Mysore, Travancore and the Central Provinces, where the disease is so common.

Samples of castor oil administered to the patients (heat and cold drawn) are submitted to a chemical analysis with the view of determining the ricinoleic acid content, which is found to have the purgative principle in it. The content of ricinoleic acid is found to vary very much from sample to sample. While separating ricinoleic acid from castor oil, an unsaponified fraction of the oil was found floating; the chemical composition appears to be of phytosterol.

Animal experiments are now conducted with a view to find out—

(i) in what form ricinoleic acid is absorbed through the lymphatics, lacteals or portal veins (probably as Sodium Ricinoleate);

(ii) such an absorption for a considerably long time, could damage the liver cells to cause cirrhosis.

The Ricin, which is a contamination of the oil, is separated out and injected through different ways to the frogs to find out its toxicity or otherwise.

A report of the findings will be submitted later.

2. Infantile cirrhosis. (A case report.)

K. NARAYANA MURTHI, Madras.

A clinical description of a case of an infantile enlargement of liver and spleen is given. The case was under the author's observation and treatment for over a period of 6 weeks. Despite all the measures taken, the disease progressed to a fatal termination. Diet containing all vitamins and so-called specifics as Extract Kalmegh, Extract Euonymin, Zinc, Mercury, Ammonium Chloride, Glucose, etc. etc. have been given without the least altering or checking the course of the disease.

A complete investigation—bacteriological, biochemical, hæmatological, serum reaction and X-ray was made in the limited time available.

The post-mortem examination results and the histopathology of some of the important internal organs are reported.

3. Epidemiology of infantile cirrhosis.

K. Narayana Murthi, Madras.

An enquiry of the incidence of this disease in India, based upon the published reports about the occurrence of the disease and the statistical record of cases collected by the author for over 3 years, is made.

The geographical distribution of the disease is marked out on a map.

The age, sex, social condition, caste, diet and the infectious nature of the disease or otherwise is discussed.

4. Endemic fluorosis in the Province of Madras.

T. N. S. Raghavachari *and* K. Venkataramanan, Guindy.

An account was published in the *Indian Medical Gazette* (July, 1937) recording the discovery of an area in this province showing a high incidence of chronic fluorine poisoning and describing the clinical symptoms of the condition, and also the geology and physiography of the area.

In a subsequent paper published in the *Indian Journal of Medical Research* for October, 1937, a detailed account was given of the clinical, radiological and biochemical findings based on the study of ten cases brought to the Government General Hospital, for expert diagnosis of the condition.

This note gives a brief account of the further investigations carried out on the fluoride content of water supplies in Nellore, Anantapur and certain other districts, and also of the laboratory experiments conducted for effecting the removal of fluorides from waters containing them.

Animal experiments were also carried out which show that mottling of the enamel of the teeth of white rats can be produced in about 3 to 4 weeks, when water containing 50 p.p.m of fluoride is given every day to the rats for drinking along with their normal diet.

5. Chemotherapy and lymphogranuloma inguinale.

V. Govindan Nair *and* V. V. Chetty, Vizagapatam.

Prontosil stands foremost to-day as a chemotherapeutic agent. It has been found to be very effective in many bacterial infections. It is also used in the successful treatment of two of the important venereal diseases, viz., gonorrhœa and chancroid. Stimulated by its success in these and also finding it useful in tonsilitis, lymphadenitis and Hodgkin's disease a condition of lymphogranulomatosis, the authors decided to try it in a virus disease, the lymphogranuloma inguinale or the sixth venereal disease of Stannus.

So prontosil rubrum was tried orally with or without intramuscular injections of jouadin in 15 cases of lymphogranuloma inguinale and 6 cases of its later manifestation 'genito-anorectal' syndrome, with very gratifying results. The conclusions are:—

(1) Every one of the 15 cases of bubo was cured. In those cases with fever, temperature came down to normal in 2-3 days and in about the same period, the pain and tenderness disappeared and the swelling diminished in size, though it took another 10 or 15 days for the complete

disappearance of the mass. In those cases complicated with syphilis, the glands after reducing to a certain extent did not subside as rapidly as before, but completely disappeared with anti-syphilitic treatment.

(2) Cases of genito-ano-rectal syndrome also showed considerable improvement by the healing of the chronic anal or vulvar ulcers, by the stoppage of the rectal discharge in those with stricture rectum, by the thinning of the infiltration of the anal margin, by the reduction in size of the elephantoid condition of the genitals and by the closing of the sinuses around the anal margin. But the stricture remains unaffected though in some cases it was found to be more easily dilatable.

(3) Though the number of cases observed is few and the experience is short, the treatment of poradenitis and its later manifestations with combined oral administration of prontosil rubrum and intramuscular injections of jouadin merits a trial.

6. Uleron in the treatment of gonorrhœa.

V. GOVINDAN NAIR *and* V. V. CHETTY, Vizagapatam.

On the finding of Schreus and others that the action of 'Prontosil' proved unsatisfactory in the treatment of gonococcal infections and feeling the necessity for an effective chemotherapeutic substance against staphylococci, further investigations, in the laboratories at Elberfeld led to the discovery of Uleron. Uleron is a disuphonamide compound having the chemical formula 4-(4′-aminobenzol-sulphonamide)-benzol-sulphon-dimethylamide.

It is used with success in staphylococcal, welchii, pneumococcal and gonococcal infections. Grutz (1937) was the first to use it in gonococcal infections with gratifying results. This was confirmed by many other German workers and it is now almost exclusively used for gonorrhœa in Germany.

After reviewing the literature which is mostly German, the authors have recorded their experiences with this drug. They treated a series of 55 cases of gonococcal infections in all stages and types and their conclusions are as follows:—

1. Of the 55 cases 32 (58·2%) were cured; 11 (20%) improved; and 12 (21·8%) failed.
2. Subacute and chronic cases responded much better than acute ones.
3. Complications such as acute epididymitis, prostatitis, conjunctivitis, adnexitis and arthritis reacted very well with the oral administration of uleron.
4. The drug was used in short courses of 3g. a day for 3-4 days at a time, at intervals of 6–8 days. With this mode of administration, toxic symptoms were practically nil. The only two bye-effects in our series were low fever and a papular rash which disappeared when the drug was discontinued.
5. In cases of gonorrhœa in women the results are not as encouraging as in men.
6. The authors think that uleron except for its low toxicity is in no way superior to prontosil album in the treatment of gonorrhœa.

7. Pellagra in Madras Presidency. Twenty-one cases of pellagra with treatment of five cases by nicotinic acid.

T. K. RAMAN, Vizagapatam.

The paper is a summary of twenty-one cases of pellagra investigated in Vizagapatam.

Classification.—

(1) Cases showing typical symmetrical exfoliative dermatitis with or without other symptoms of pellagra. (12 cases.)
(2) Pellagra occurring in the course of other diseases; co-existant disease has nothing to do either with the onset or progress of the disease. (3 cases.)
(3) Pellagra occurring in the course of other diseases; co-existant disease has either precipitated the onset or made condition of patient worse. (6 cases.)

Brief summary of cases given.

Symptoms.—Symmetrical exfoliative dermatitis with a distinct line of demarcation; anæmia of a microcytic, normocytic or macrocytic type; low protein content with diminished albumin; normal blood sugar, calcium, and phosphates. Blood Cholesterol low. Normal diastase and increased porphyrine in urine. Gastric analysis—increased, normal or low acidity and absence of free HCl. Microphotographs of skin changes given. *Treatment*: liberal diet; milk, bread, fruits, rice, eggs and liver soup. Liver extract 2 c.c. daily or every alternate day intramuscularly. After the treatment the general condition improves, dermatitis disappears, blood count increases, blood proteins become normal, HCl is increased or appears in cases in which free HCl is absent. Nicotinic Acid (60 to 90 mg. daily for ten days by mouth) tried in five cases. Two cases showed considerable improvement; in three cases nicotinic acid has been a failure. Aetiology of pellagra discussed.

8. A study of the blood picture in septicæmic plague.

N. SESHADRINATHAN *and* D. R. ANNAMALAI, Guindy.

The authors consider that their observations on the blood picture in septicæmic plague will form a useful addition to the existing literature on the subject, as such cases are not common and the blood picture does not appear to have been definitely described so far. A study of the leucocytes is the chief feature of this paper. Relative mononuclear increase, noted in plague septicæmia has been strikingly observed in this case also. Degenerative changes of the leucocytes form a marked feature.

9. The incidence of Filariasis in relation to malaria in Ceylon.

W. L. P. DASSANAYAKE, Ceylon.

Investigations were carried out in two Chief Headmen Divisions, in Ceylon, to determine the effect of malaria infection on the incidence of Filariasis. The results obtained show that heavy filarial infection, as indicated by 40% Microfilaria rate, can co-exist with heavy malaria infection, as indicated by a spleen rate over 40%.

The malaria infection does not appear to have any inhibitory action on the filarial infection. Even after a severe malaria outbreak with heavy mortality—death rates per 1,000 population being over 100%—the microfilaria rate of 40% had been detected in the same locality.

10. Studies in the pathology of hæmolymph organs in cholera.

H. N. CHATTERJEE, Calcutta.

In the bone-marrow the normally closed and collapsed capillaries dilate and are filled up with red blood corpuscles.

The spleen shows enlargement. There is a marked engorgement of red pulp. The lymphatic elements of the spleen show a marked hyperplasia.

Liver shows dilatation of the sinusoids and their filling up by the red cells. The changes do not affect the whole liver uniformly. One unusually sees apparently normal areas side by side with the congested areas.

The thymus is seen remarkably enlarged in a good proportion of the cases.

There is a marked enlargement of the mesenteric lymph glands with hyperplasia of the lymphatic structures. The enlargement of the solitary follicles have been already dealt with.

Besides the above, lymphatic nodules are also seen in some uncommon situations such as the bone-marrow and liver.

11. Studies in the pathology of the gastro-intestinal tract in cholera.

H. N. Chatterjee, Calcutta.

Agglutinable cholera vibrios are isolated from 80% of post-mortem cases.

Actively inflammatory and ulcerative lesions are not common in the intestines of cholera post-mortem cases.

A peculiar capillary dilatation of the mucus membrane and submucus coat of the small and large intestines is a common feature.

Hyperplasia of the solitary lymphatic follicles is seen in many cases especially the more severe ones.

12. Studies in the histo-pathology of the endocrine glands and the pathology of some other organs and tissues in cholera.

H. N. Chatterjee *and* J. K. Sarkar, Calcutta.

Various changes occur in the thyroid, adrenal, pituitary and thymus glands.

Gall-bladder is distended and there is stasis of bile in almost every case. This seems to be rather due to a neuro mechanism than to any gross structural change.

Acute capillary dilatation occurs in various organs such as bone-marrow, spleen, heart muscle, mucus coat of the intestines, etc. which can explain the various symptoms, e.g. shock, vasomotor failure, hæmorrhages, etc.

There are other organs and tissues which escape this capillary dilatation particularly the skeletal muscles and the subcutaneous tissues.

13. Further studies in the biochemistry of anæmia of pregnancy.

H. N. Chatterjee *and* S. M. Ghosh, Calcutta.

There is an increase of the serum globulin in the normal pregnancy cases but the rise in cases of anæmia of pregnancy is very much more remarkable.

The great increase in the globulin is due to the rise of Euglobulin fraction.

There is a marked increase of total cholesterol of the blood in cases of normal pregnancy, there is a marked diminution of the same in the pregnancy anæmia cases, the figures being much lower than the non-pregnant normal females.

Ester cholesterol fraction shows a remarkable diminution; the free cholesterol might be normal, a little below normal, or might show a figure slightly higher than normal.

14. Further observations on 'coronary occlusion'.

J. N. MAITRA, Calcutta.

Sudden death in persons with coronary disease.

Coronary thrombosis *versus* non-thrombotic coronary occlusion and their relations to sudden death.

Separate identity of a spasmodic type of coronary occlusion and its differential diagnosis.

Treatment of chronic coronary occlusion.

Bacteriology

15. Longevity of coliform organisms in water stored under natural conditions.

T. N. S. RAGHAVACHARI *and* P. V. SEETHARAMA IYER, Madras.

Clemesha (1908-09) grouped coliform bacteria in water, fæces and cow dung, into 3 classes on the basis of their powers to resist the action of sunlight and other forces in nature and claimed that the comparative recency or antecedence of pollution in water supplies could thereby be determined with considerable precision.

Subsequent work by the authors since 1914 tended to throw an element of doubt on this classification and on the claim.

Webster (1934) working with laboratory cultures found that coliform bacilli of Clemesha's class I, lived on Winchester quart bottles of sterilized distilled and sterilized river water for 62 and 34 days respectively.

The present note relates to experiments carried out with Adyar river water stored in open masonry reservoirs 30′×30′×6′ for four months during the monsoon season and for six months during the hot weather.

Coliform organisms of Clemesha's Class I (susceptible to sunlight and storage) were isolated in 32 out of 46 samples between November, 1937 and March, 1938 and 216 out of 564 cultures isolated belonged to Class I.

During the hot weather, only 16 out of 41 samples showed their presence and 54 out of 405 cultures belonged to Class I. Though comparatively fewer in number, the Class I organism was isolated from the water after four months of storage and exposure to sunlight.

If the modern classification of coliform bacteria into *B. coli* and *Intermediate-ærogenes-cloacæ* is applied to our results, 80 per cent. of the organisms found during the monsoon period and 60 per cent. of those found during the hot weather belong to the true *B. coli* type.

The authors do not, therefore, consider it safe to rely on Clemesha's classification in the assay of potability of waters.

16. The technique of M.R. and V.P. tests used in bacteriological water analysis.

P. V. SEETHARAMA IYER *and* T. N. S. RAGHAVACHARI, Guindy.

This note relates to the technique of two of the five tests usually applied to *coliform* bacteria isolated from water. Several modifications which have recently been proposed for intensifying the colour change in the V.P. test were tried by the authors.

Barritt's modification using alpha-naphthol and KOH was found to be the most sensitive and specific in a series of over 3,000 cultures obtained from 600 samples of water.

The authors advocate the use of a single tube of buffered glucose phosphate broth for each culture, on which both the M.R. and V.P.

tests (Barritt's modification) could be carried out successfully instead of the time honoured method of using one tube for each test.

The above procedure conduces to economy and simplifies the technique.

17. The coli-aerogenes index of pollution used in water analysis.

T. N. S. Raghavachari *and* P. V. Seetharama Iyer, Guindy.

The presence of coliform organisms in water is used as an index of pollution and several methods and tests have been advocated during recent years to differentiate between fæcal and non-fæcal types. Prof. Wilson and his assistants at the London School of Hygiene and Tropical Medicine have recently advocated a particular method, whereby the material under test is to be first enriched on MacConkey's broth at 37°C. and each of the presumptive positive tubes is then subcultured into citrate at 37°C. and MacConkey's broth at 44°C. (in a water bath, *not* incubator). By this method, they claim that a clear differentiation between *coli* and *aerogenes* can be obtained as also a fairly accurate numerical assay of the two types present in the material.

This method has subsequently been found by Bardsley to work efficiently and uniformly well in the case of fæces, water, milk, ice-cream and shell fish at Manchester.

The application of the method to 12 samples of water, derived from lakes, wells and rivers (unfiltered and filtered) in the province, has, however, yielded results which are at variance with Wilson's and do not, therefore, establish the claim for specificity of the method; for, about 50 per cent. of the organisms of the *aerogenes-cloacae* group isolated from waters have been found to produce acid and gas in MacConkey's broth at 44°C. under the conditions of the test laid down by the sponsors.

Our main contention that some strains of *B. aerogenes* isolated from Indian waters produce acid and gas in MacConkey broth at 44°C. has been confirmed by carefully controlled tests on pure strains isolated from water.

Conclusion.—Clearly, the MacConkey test at 44°C. cannot be relied upon in India for differentiating fæcal from non-fæcal coliform organisms, unless it can be shown that the *aerogenes* growing at 44°C. is a normal *inhabitant* of the Indian intestines.

18. Staphylococcus aureus in vaccine lymph.

K. Padbhanabha Menon, Guindy.

115 strains of *staphylococcus aureus* isolated from 115 cups of vaccine lymph at the time of manufacture were tested for pathogenicity by in vitro reactions and by toxicity in animals by intradermal injections of the filtrates of broth culture. Seventeen strains gave positive reactions to all in vitro tests; 51 were negative for all tests; 47 were positive for one or two tests only. The toxicity test was positive for only two strains. The toxicity test was negative when the same organism was isolated from the same cup after storage in contact with 50% glycerine at a temperature below 0·0°C. over three months. Most of the strains were negative to other pathogenicity tests as well.

19. Bacteriophage and candle filtration.

L. R. S. Deo, Patna.

Bacteriophage behaves more like a virus. The finding of Kendall that he could separate phage from autoclaved sewage could not be corroborated in this laboratory. The experiments with Filtre Chamberland

Systeme Pasteur show that finer grades of coarse candles are preferable for bacteriophage work.

Nutrition

20. Insoluble ash of cereals and its effect on nutrition.

C. V. Sabnis *and* B. N. Banerjee, Bangalore.

Three family diets in the Mysore State representing: (i) middle class Brahmin, (ii) middle class Christian (income of Rs.100 p.m.), and (iii) a village farmer have been analyzed. They are poor in proteins (8% to 10%) and fat (5–7%) and low in mineral calcium and phosphorus (0·1%, 0·14%). Albinos have been fed with these diets and their growth rate observed. Increasing the protein content by increasing the gram ratio there is improvement in growth response. Increasing the vitamins by adding extra green leafy vegetables, or otherwise, the growth rate is improved. The mineral intake (calcium and phosphorus) is greatly affected by the presence of a large proportion of insoluble ash in the grains grown on the Mysore plateau—artificially by the addition of silt clay to a synthetic diet, on the above ration, very very poor growth and mineral metabolism has been observed. The role of insoluble ash from cereals in depressing growth rate and calcium assimilation has been established.

21. Calorie requirements of South Indian children.

B. G. Krishnan, Coonoor (S. India).

(Indian Research Fund Association.)

The problem of satisfactory calorie standards is one which constantly arises in practical nutrition work. An investigation of the energy intake of boys belonging to 5 age groups was carried out with the object of establishing suitable standards. The boys were healthy and living in an institution which provided more than sufficient food to satisfy appetite. The diet was well balanced and generally satisfactory. Energy intake, calculated from consumption for a week, was as follows:—

Age group.	*Calorie intake.*
2 and 3	870
4 „ 5	1,140
6 „ 7	1,300
8 „ 9	1,600
10 „ 11	1,760

There was fair correspondence between observed consumption and the standards of energy requirements which are now being used in practice in South India. The latter are based on an allowance of 2,500–2,600 calories for an adult man, the needs of the various age and sex groups being stated as fractions of this allowance in terms of the scale of family coefficients set up by an Expert Committee of the League of Nations Health Organization in 1932.

22. A survey of diet and nutrition in Najafgarh, Delhi Province.

K. L. Shourie, Coonoor (S. India).

(Indian Research Fund Association.)

A survey of diet and nutrition was carried out in Najafgarh, Delhi Province. The diet of 101 families, comprising 531 persons, was studied for a period of about 10 days; the majority of these were from villages but some families living in Najafgarh town were also included. The diets, based on whole wheat and millet, and containing fair quantities of milk, were found to be satisfactory in certain respects; intake of calories, protein, calcium, Vitamin A and Vitamin B_1 was higher than that observed in village surveys in South India. There was, however, a marked deficiency of vegetables and fruits, which represents the chief defect of the diet. Daily intake per adult man of Vitamin C was calculated to be less than 6 mg.

The state of nutrition of 1,483 children was investigated. The average height of the boys was similar to that of South Indian boys, but the Najafgarh boys were a little heavier at all ages. Signs of deficiency disease were rare and the general condition of the children good. 90–95 per cent. were free from caries and dental irregularities.

The diet of the District Board School Hostel, housing 19 persons, was investigated during the cool and hot seasons. Calorie intake was found to be somewhat reduced during the hot weather but the reduction—from 2,900 to 2,600—was not very great.

23. Serum phosphatase activity in rats fed with different diets.

K. V. GIRI, K. L. SHOURIE, *and* K. RAJAGOPAL, Coonoor (S. India).

(Indian Research Fund Association.)

The superiority of serum phosphatase determination over serum phosphorus and calcium determinations for the diagnosis of rickets is now well recognized. Recent work has revealed certain relationships between the activity of blood phosphatase and certain dietary deficiencies. Since typical poor South Indian diet, largely based on rice, is very deficient in mineral salts, particularly calcium (Aykroyd and Krishnan, *Ind. J. Med. Res.*, 1937, *27*, 365), and the addition of calcium lactate to such a diet enhances growth and improves the general condition of the rats, it was thought that a study of the changes in serum phosphatase activity in relation to dietary changes, would be useful in interpreting the nutritive value of such diets. The phosphatase activity of the blood serum of rats, fed on a poor South Indian diet supplemented with calcium lactate and excess of fat was investigated. The activity of the serum phosphatase showed a much greater increase in rats receiving this diet alone than in those receiving the same ration supplemented with calcium lactate. Addition of excess of fat in the form of gingelly oil increased phosphatase activity 5 to 8 times as compared with that observed in rats fed on the unsupplemented basal diet. Changes in the phosphatase activity of serum on keeping and its response to magnesium activation have also been studied.

24. The availability of cereal phosphorus and calcium for rats.

K. V. GIRI, Coonoor (S. India).

(Indian Research Fund Association.)

The availability of phosphorus and calcium of some Indian cereals was determined by metabolic experiments on rats. The rats were given a calcium and phosphorus deficient diet, which was otherwise adequate for normal growth. The basal diet was supplemented with rice (*Oryza sativa*), ragi (*Eleusine coracana*), cambu (*Pennisetum typhoideum*) and cholam (*Sorghum vulgare*), which were the main sources of phosphorus and calcium. The balance of phosphorus and calcium was obtained by measuring the total intake of these elements and their excretion in urine and fæces.

It was found that all the phosphorus present in cereals and the calcium contained in ragi are not completely 'available'. The phosphorus and calcium excretion in urine was found to be very low when compared to their excretion in fæces, and about 50 per cent. of the total phosphorus excreted in fæces is in the form of organic phosphorus.

25. Interaction of Vitamin C and tissue phosphatases.

K. V. Giri, Coonoor (S. India).

(Indian Research Fund Association.)

Investigation on the effect of Vitamin C on the activity of tissue phosphatases have shown that the activity of alkaline and acid phosphatases of kidney, liver and brain are inhibited by the Vitamin C-Cu complex. Vitamin C or copper alone has no effect on their activity. The phosphatase activity of crude aqueous extracts of tissues with the exception of that of brain is not influenced by the Vitamin C-Cu complex, while the activity of extracts purified by dialysis is inhibited by the complex. This difference in the behaviour of the extracts was found to be due to the presence of some factors in crude extracts, which protect the vitamin against oxidation. The inhibition by Vitamin C-Cu complex was entirely or partly annulled by glutathione, cysteine, cystine and reducing agents like NACN and sodium hydrosulphite. It is suggested that Vitamin C, copper and protective substances like glutathione which occur together in all tissues, play an important role in the regulation of the activity of tissue phosphatases.

26. Diet in requirement of copper for infants.

U. P. Basu, Barnagore, Calcutta.

Recent researches (cf. Daniels and Wright, *J. Nutrition*, 1934, *8*, 125; Elvehjem, Duckles and Mendenhall, *Amer. J. Dis. Child.*, 1937, *53*, 785; Chou and Adolph, *Biochem. J.*, 1935, *29*, 476) have shown that infants and children of pre-school age require about 0·1 mg. of copper per kg. of the body weight per day for their proper growth. But milk, the main diet for a considerable period of time for the former, are extremely low in copper. The various cereals rice, wheat, sago, suji, pala, barley, etc., usually consumed, have been analyzed and found to contain in average 0·323 mg. of copper per cent. Barley, milled, the cereal that is largely used in infant feeding contains only 0·351 mg.% copper and cow's milk is being found to vary in its copper content, the average percentage being 0·019 mg. A sample of human milk has been found to contain more than thrice this amount. From these, it is evident that even if the metal present in barley be completely available for the system, an usual diet of an average infant below six months of age, consisting of cow's milk and barley, milled, would not be sufficient for his copper requirement. The question therefore rises whether any salt of copper should be added to a diet of an infant who is particularly being artificially fed.

27. Studies on the availabilities of phosphorus and calcium in rice.

Y. V. S. Rau *and* V. V. S. Murthy, Bangalore.

Toxicology

28. Fatal poisoning by paranitraniline.

K. N. Bagchi, H. C. Chakravarti, *and* H. D. Ganguli, Calcutta.

All aniline dyes are more or less poisonous. Some of them have been known to produce poisonous effects by absorption through unbroken skin. Children develop symptoms of aniline poisoning by wearing boots made of leather coloured and polished with aniline dyes. So far no case of poisoning by paranitraniline has been recorded, although it is used as a yellow dye in textile industry.

Seven drums of this dye-stuff were imported to Calcutta from France. Two coolies while unloading happened to make a free use of this yellow dye by rubbing each other's head, face and body just as they do with the common red dyes during the holi festival. In 6–8 hours they became unconscious and were removed to the hospital where one of them died on the third day and the other recovered. No poisonous substance was detected in his stomach contents nor in the viscera but a trace of a yellow dye resembling paranitraniline was isolated from his urine.

The original dye stuff was found to be a powerful poison and when applied to the abdomen of a frog, a rat and a cat as a 20 per cent. ointment with vaseline, killed them in quick succession showing how easily it is absorbed through unbroken skin. The absorption through skin is helped by heat and moisture and the fatal incident took place in July in the hatch of a steamer in the port of Calcutta.

29. Studies on toxicology of *Execaria agallocha* and difficulties in the way of medico-legal investigations.

K. N. BAGCHI, H. D. GANGULI, *and* P. N. MUKHERJEE, Calcutta.

There are hundreds of powerful indigenous poisons of vegetable origin but their nature and composition are unknown and thus many cases of criminal use of such poisons remain undetected. The analyst is not provided with all relevant informations required for such analysis by the investigating officers who usually try to avoid giving even a short history of the case probably to test the efficiency of the analyst.

The milky juice (latex) of goma tree (Execaria agallocha) growing to a large size in the districts of Bakharganj, Chittagong and other places of Bengal, is known to be a poisonous substance. It is used in the indigenous system of medicine for treating epilepsy, leprosy, etc. (Nadkarni) and its criminal use for suicide, homicide and also as an abortifacient is well known even amongst the village folks in these places. The local people also attribute to it an important property of curdling milk and producing 'dahi' of much better consistency.

Investigations as to its chemical composition and toxic principles have been taken up in connection with the suspicious death of a pregnant woman of about 25 years alleged to have taken the latex with milk either for abortion or for suicide. It has been found to be a nitrogenous substance having no alkaloids or glucosides. A full grown cat fed with 2 c.c. of the latex died in about 35 minutes. There was vomiting, purging, salivation, protrusion of the eye balls, dilatation of the pupils and air hunger. The investigation is in progress.

Surgery

30. The treatment of dislocations of elbow and its complications with a simple technique for excision of elbow.

M. G. KINI, Vizagapatam.

The development of orthopœdic surgery in India has not kept pace with the development of other branches of surgery, as fracture setting is still in the hands of the crude bone setter in South India. 30 out of the 38 dislocations of the elbow which were badly treated by the bone setter afforded an unique opportunity to study the complications resulting therefrom. The treatment of recent dislocations will result in the satisfactory restoration of function if the following method is adopted:—

Every case of dislocation of elbow must be reduced under an anæsthetic, and after reduction, must be supported in plaster of Paris splints with the elbow in flexion and forearm in supination for a fortnight. At the end of this period the plaster of Paris splints must be discarded and active movement with massage must be started. It was found at the end of 2 months the restoration of function became normal. 8 such cases were treated and a follow-up replies received from some of the cases that replied and the examination of those who reported in person show that the results of this line of treatment has been very good.

The most important complication of dislocation of elbow was the development of new bone in front and behind the elbow joint commonly called 'Myositis Ossificans'. It occurred in all cases treated by the bone setter who employed forced movements to restore the function of elbow after reducing the dislocation. A few cases remained unreduced. It is well known in dislocations of elbow that there is a tear of ligaments, capsule with blood vessels, resulting in an effusion and in the healing process granulation tissue is formed which normally is converted into fibrous tissue. As a result of bad treatment it forms the pre-osseous substance in which new bone gets deposited. The usual complaint for which these cases seek admission is a fixed elbow. Removal of new bone by operation has not resulted in satisfactory restoration of function in conditions of well marked myositis ossificans. In unreduced conditions of dislocations of elbow and in cases of myositis ossificans the operations of choice are arthroplasty and excision of elbow. Arthroplasty though a very useful operation requires more time and was employed in one case but was not repeated due to difficulties in developing a team well versed in the no-touch technique who can help the surgeon in preparing the fascial graft when the excision was being carried out, to minimize the period of time of anæsthesia. A simpler method of excision of elbow was tried and though the technique of excision was the same as mentioned in textbooks yet the after-treatment deferred as follows:—

Every excised elbow was put in extension by skeletal traction with Kirschner's wire through the lower end of the radius and ulna in a Thomas's arm splint for a fortnight. This step helped to keep the excised ends well apart until the healing was complete. At the end of a week, the sutures were removed and at the end of a fortnight the Kirschner's wire was removed and active flexion with support was encouraged. If on the first day an active flexion of 160° could be obtained, it was considered satisfactory. To prevent effusion the elbow was put in plaster of Paris casing. Active flexion with support was encouraged from day to day until an acute flexion was obtained and when this stage was reached the patient was encouraged to do active movements under supervision and physio-therapeutic measures were instituted at the same time. At the end of a month it was found that the patient could flex and extend the elbow without any support and at the end of two months movements could be done against resistance. The result of this simple excision has given the same satisfactory results as arthroplasty. A follow-up of the cases with pictures taken showing the functional range of the movement of the joint, shows the usefulness of this simple method of excision. The cosmetic effect and the functional result for lifting of weights has been found satisfactory.

31. The use of tannic acid in burn.

C. A. Rothenheim *and* S. S. Cowalagi, Bombay.

Describes experiments using horse serum for finding the optimum conditions for the use of tannic acid in burn therapy as a non-greasy ointment with the following conclusion:—

1. A 12% solution of tannic acid is the optimum concentration for the production of a good crust.
2. Tannic acid in ringer solution is more efficient than in normal saline or in pure water.
3. The natural *p*H of the 12% solution, viz., 3·75 is more suitable than solutions of higher *p*H.
4. The incorporation of acriflavine as preservative and antiseptic has been found to be efficient.

General

32. Medicine in India in the middle of 16th century.

D. V. S. Reddy, Vizagapatam.

A cross-section of medicine in the middle of the 16th century based on the first medical work in a European language (Portuguese) published in India by Garcia da Orta, a Portuguese physician who practised in India.

Medicine of the age consisted in learning about drugs and how physicians use them. The Universities of Europe dealt also with ancient classics of Greek, Latin and Arab writers. Anatomy and Physiology in the modern sense were not yet born. The humoral pathology still held the field in the European as well as the oriental systems of medicine. Materia Medica was extensive but the terminology describing the qualities of drugs and actions of drugs were those of the Greeko-Roman schools (warm, cold, humidity, dryness, etc.). Drugs were classified according to degrees or the supposed seat of action. The methods of establishing the action of drugs savoured more of philosophy and metaphysics than observations or experimental proofs. Action of drugs was also based on the existing incorrect ideas of Anatomy and Physiology. The clinical effects of drugs however were noted by keen observers. A few enterprising persons attempted experiments to demonstrate the effect of drugs (e.g., Rhinoceros horn, Porcupine stone, poisons like Pisso).

Diseases of the period:—Cholera, Dysenteries, Fevers (various types), Syphilis, Leprosy, Smallpox, Measles, Plague were among the infectious and epidemic diseases. Bladder complaints, diseases of the kidney, skin diseases, nervous diseases of women, intestinal parasites, Asthma, Scrofula, Rheumatism, Melancholy, Colic, were other common diseases. Poisoning was very common and there were many drugs to counteract poison. Three chief systems of medicine were in vogue in the country: (1) The Indigenous system based on Ayurvedic writers, tradition or hereditary custom. (2) Mohammedan physicians who came from Turkey, Arabia and Persia and practised according to Rhazis and Avicenna. (3) European medicine, Portuguese and Spanish medicine in particular, as taught in the Universities of Salamanca and Alcala, based on Greek, Latin, Arab classics and medieval or renaissance writers, commentators and translators of these texts was just beginning to spread into India. A number of Portuguese druggists and Portuguese physicians popularized this system. Many kings and princes who had Hindu and Mohammedan physicians were requisitioning the services of Portuguese physician. The foreigners were in their turn imbibing some of the good features of indigenous medicine and adopting those methods. People and physicians occasionally allowed their prejudices to dominate over reason. The difference in the methods of treatment adopted by the Hindu, Mohammedan and Portuguese physicians is sketched. Brief biographical notes of Hindu, Mohammedan and Portuguese physicians and druggists. Side lights on popular medicine.

B. VETERINARY RESEARCH

Clinical Pathology

33. A clinical investigation into the etiology of rickets in pups of an indigenous Indian breed.

P. C. Banerji *and* K. Raghavachari, Mukteswar.

The article records interesting cases of rickets in puppies in the kennels of the Imperial Veterinary Research Institute, which do not apparently fit in with the established conception of the etiology of this disease in such animals and it is hoped that the observations recorded will throw further light on the etiology of rickets in dogs.

34. Observations on malaria in buffaloes.

S. R. Hassan *and* M. R. Dhanda, Mukteswar.

The occurrence of natural infection of malaria in buffaloes is confirmed. Symptoms exhibited by the animals after a natural attack are—a fever lasting a day or more accompanied by the presence of malarial parasites (*Plasmodium bubalis*) in the peripheral blood and followed in some cases by digestive disturbance and diarrhœa. The fever may be intermittent or continuous but in most cases where the course of the disease is mild, it appears but once lasting for only a day or two. The course of the disease is short and recovery is spontaneous.

An acute case resulting in death caused by this parasite is recorded. The morbid changes noted at autopsy were: dark colouration of the internal organs due to the presence of pigment. Enlargement of the liver and spleen and the presence in these organs of large numbers of parasites in different stages of development and also of free pigment in the leucocytes as well as in the blood.

The presence of gametocytes in the peripheral blood of animals which showed parasites in the blood for a long time is also recorded.

35. Visceral gout of fowls in India.

S. Ganapathy Iyer, Mukteswar.

Cases of visceral gout in fowls have been recorded in this paper; for the first time in India. The clinical and the pathological aspects which simulated the description given in text books are described. All the viscera contained in the thoracic and abdominal cavities were covered with a chalky uratelike deposits. The possibility of bacterial infection was eliminated and the etiological factor has been discussed.

36. 'Deg Nala' disease of buffaloes—an account of the lesions and essential pathology.

J. F. Shirlaw, Mukteswar.

The paper records observations made on the clinical and pathological aspects of a hitherto undescribed disease of buffaloes occurring in a marshy low-lying track of land bordering the Deg tributary of the river Ravi in the Punjab, and hence termed the 'Deg Nala' disease. The clinical syndrome encountered in the disease had been noticed in sporadic cases but it was only about eight years ago, when the disease assumed an epizootic character, that investigation was undertaken to determine its etiology and the means of control. Clinically the disease is evidenced primarily by general malaise, followed by progressive cachexia and the development of apparently non-inflammatory œdematous swellings on the tongue and the extremities. In fatal cases these swellings undergo necrosis and gangrene but in other cases, induration of the affected parts results, resulting in elephantiasis like lesions.

Histologically the outstanding abnormality noticed is in the terminal arteries which show various stages of a process culminating in a total occlusion as a result of an insidious mesarteritis accompanied by abortive attempts at establishment of a collateral blood supply. Occlusion of the pre-existing and also of the newly formed vasa vasorum results in nutritional impairment of the arteries and probably explains the genesis of the lesions. Although certain histological features point towards a helminthic origin of the disease, no direct evidence has been obtained in support of either a parasitic or a toxic etiology of the disease.

Protozoology

37. Observations of *Babesia foliata*, n.sp. from a sheep.

H. N. Ray *and* K. Raghavachari, Mukteswar.

The authors in this article report the occurrence of a new species of *Babesia* which they found in the blood of a sheep subjected to a Blackquarter Vaccine test at the Imperial Veterinary Research Institute, Mukteswar. With a rise of temperature the blood of this animal was submitted as a routine for microscopical examination and the species of *Babesia*, which was encountered, was found to differ morphologically from all the three species, viz. *B. motasi*, *B. ovis*, and *B. surgenti*, known so far to infect sheep and goats. The differences are, as indicated in the table below:—

Characters.	B. motasi.	B. ovis.	B. surgenti.	B. foliata, n.sp.
Shape	Pear-shaped, singles and pairs.	Pear-shaped forms rarely seen. Singles. Majority round.	Rounded and bacillary.	Flattened, pear-shaped in outline. Mostly seen in pairs.
Size in μ	2·5 to 4× 1·2 to 3.	Never exceeds 2.	?	2·065 to 4·13× 0·5 to 1·5.
Angle between the pairs.	Acute	Obtuse	....	Majority obtuse.
Position in the red blood corpuscle.	Centre	Margin	Centre(?).	Majority centre.
Effect on the parasitized corpuscle.	Hypertrophy.	No change	No change (?).	No change

On minute study the organism was found to be flat, leaf-like with pear-shaped outline and it is on this morphological peculiarity that the specific name *foliata* has been proposed for this new parasite. The chromatin in the nucleus as revealed by Feulgen's reaction was found to be confined towards the narrow pole of the parasite. The organism and anæmic changes as well, persisted in the blood till the death of the host. Hæmoglobinuria was absent. Two lambs and two kids were inoculated with the infected blood, of which kids failed to take up the infection, while one lamb showed the parasites on the third and fifth day and the other on the fourth and twenty-first day, after the infective inoculation. Presence of parasites in these inoculated lambs was accompanied by thermal reaction.

Bacteriology

38. Biochemical classification of streptococci associated with strangles in India.

R. L. Kaura *and* S. Ganapathy Iyer, Mukteswar.

In this paper the authors have recorded the results of their attempts to classify thirty-one strains of apparently pure cultures of beta hæmolytic streptococci isolated from cases of strangles by newer biochemical methods of classification such as fermentation of selected carbohydrates, e.g. lactose, mannite, salicin, sorbite and trehalose, determination of the final *p*H of glucose broth cultures, hydrolysis on blood agar and titration of hæmolysin.

Strains of streptococci fermenting only sorbite and salicin with no action on lactose were encountered to a considerable extent in these specimens and it was not possible to classify them under any of the known types.

Out of the total number of thirty-one strains, by the application of carbohydrate fermentation reactions, twenty-two and nine fell under *Streptococcus equi* according to W. H. Colman and P. R. Edwards, respectively. The limited value of the carbohydrate fermentation reactions alone in the differentiation of streptococci was confirmed.

39. The value of synthetic media in the preparation of mallein.

R. L. Kaura, Mukteswar.

Synthetic media were tried in the preparation of mallein with a view to the elimination of the non-specific reactions which may occasionally be encountered with this product when prepared in a medium containing animal proteins. Reid's modification of Sauton's medium, with two per cent. glycerine instead of six per cent. and *p*H adjusted to 7·4 gave the most satisfactory results.

Four brews of mallein, two for intra-dermo-palpebral and two for subcutaneous use, were prepared in this medium and in each case the growth of *Pf. mallei* was comparable with that obtained in the routine medium, i.e. 2 per cent. glycerine broth. With these experimental brews the reactions produced in the infected ponies were better than those commonly observed with the routine brews and in the healthy controls there was no reaction.

40. Detection of anthrax in food stuffs in an outbreak among mules.

V. R. Rajagopalan *and* V. R. Gopalakrishnan, Mukteswar.

A technique for detecting anthrax in food materials of domesticated animals is described.

While attempting to incriminate anthrax as the probable etiological factor in an outbreak among army mules in Razmak (India), the method of late Prof. Krishnamurty Ayyar (1927) was followed, with some modifications, to isolate *B. anthracis* from food materials.

A number of samples of various food stuffs were extracted separately in saline and laboratory susceptible animals such as guinea-pigs were experimentally injected under the skin with the above. It is noteworthy to record here that pure culture of *B. anthracis* was recovered from a sample of green fodder (Maize) supplied by an officer of the Army Veterinary Corps, India.

Incidentally, when the fodder extracts (heated and unheated were submitted to laboratory examination, it afforded an opportunity of demonstrating clearly the phenomenon of antagonism between *B. anthracis* and *Pseudomonas aeruginosa.*

Entomology

41. Pasteurellosis in white mice.

V. R. Rajagopalan *and* V. R. Gopalakrishnan, Mukteswar.

An outbreak of rodent septicæmia in white mice, maintained at the Imperial Veterinary Research Institute, Mukteswar, is described.

The causal agent—a member of the Pasteurella group—was subjected to a detailed study. It was found to be culturally, morphologically and biochemically very closely related to or probably identical with *Pasteurella muricida* Meyers and Batchelder, 1926.

A comparative serological study of the organism with some strains of Pasteurella in our stock and their relationship are also discussed.

This appears to be the first record in India of the occurrence of *Pasteurella muricida* as the cause of an epizootic among rodents.

42. Further observations on the bionomics of the ox warble-fly (*Hypoderma lineatum*) in India.

B. N. Soni, Mukteswar.

The seasonal occurrence of *Hypoderma lineatum* in India differs markedly from that recorded for the British Isles. In India itself, it varies for different localities, this probably depending upon the variation in both climatic and topographical factors. The statement is illustrated with the aid of a calendar.

The occurrence of young forms of migrating larvæ of *H. lineatum,* in the animal's body, has been recorded, at Mukteswar, from the oesophagus, trachea, rumen, aorta, diaphragm, muscular tissues of the vertebral column, neural canal and the intercostal muscles. It has been further noticed that the larvæ are capable of causing hæmorrhage in the oesophagus and ingesting the extravasated blood.

The presence of young larvæ of *H. lineatum* has been recorded for the first time from the oesophagus of goats. This would appear to point to the conclusion that the pest has a similar life-history in the two types of hosts, namely, cattle and goats.

The result of a short survey in the Salt Range area of the Punjab showed that the warble larvæ infesting sheep in that area belong to the species *H. lineatum.*

43. On a new trombidiid larva parasitic on the house rat (*Rattus rattus* var.).

M. Abdussalam, Lahore.

Trombidiid larvas have not attracted the same attention in India as in some other countries in the east, apparently because they have not been seriously incriminated as transmitters of tropical typhus in this country. Only about seven species are known, all described by two workers. Hirst and Ewing who had occasionally received stray collections from India.

A few specimens of the form described in the present paper were found in the external ear of a house rat caught at Mukteswar (Kumaun hills, U.P.). Details of its morphology and systematic position have been discussed in the paper and it has been named as *Gahrliepia homunguis*, sp. no. Validity of the closely allied genus *Schongastiella* Hirst has also been discussed.

44. A technique for cutting serial sections of chitinous objects.

S. N. SAPRE, Mukteswar.

In the course of his studies on the anatomy and histology of *Ornithodorus crossi*, the author was successful in developing a suitable method for cutting serial sections of chitinous objects. This consisted in the use of (1) a fixative evolved by the author; (2) 'diaphanol' as a softening agent for chitin without injury to the internal parts; and (3) dionan, instead of alcohol, for dehydration.

45. *Ornithodorus crossi*, Brumpt, 1921, as a valid species and not a synonym of *Ornithodorus papillipes*, Birula, 1895.

S. N. SAPRE, Mukteswar.

The name *Ornithodorus crossi* was proposed by Brumpt in 1921 for a species of tick occurring in the Punjab, and specimens of which were forwarded to him by Cross for identification. Nine years later, Parlovsky produced evidence to show that this name was antedated by *Ornithodorus papillipes* and, therefore, in accordance with the rules of priority, the name *O. crossi* fell into synonymy.

The author, in the course of his studies on the morphology of this species, found that it lacked certain characters which are present in O. papillipes, Birula, and are utilized in distinguishing the latter from other allied species, the most important of these being the tuft of hair arising from the conical anterio-ventral surface of the body in front of the camera sterne. In view of these facts *O. crossi* may be regarded as a valid species.

46. The possibilities of cattle fly sprays in India.

S. K. SEN, Mukteswar.

The two factors which impose a limitation on the value of repellent sprays in combating cattle flies in India are their liability to cause burning of the skin and their high cost compared with the benefit they may be expected to accrue from their use in the case of cows of low milk yield. The paper discusses the possibility of overcoming these difficulties in the light of the results of a series of fly repellancy tests which were carried out in one of the Government Cattle Farms in the United Provinces. In the course of these tests, it was observed that a spray consisting of high speed Diesel oil, 'Pyrocide 20' (a concentrated extract of pyrethrum flowers) and Pine oil, when applied on Sahiwal cows for 21 consecutive days, during October, did not produce any burning or scurfing of the skin, although the spray proved to be very effective against *Musca crassirostris* and *Lyperosia exigua* which were at the time the two prevalent species of biting flies on the farm. About 60 c.c. of the fluid was used for each spray and the cost of this quantity was slightly less than six pies. In view, however, of the results recorded in this field by workers in other countries, it is probable that a much smaller dose would prove equally effective. The use of the spray was also found to result in an appreciable increase in the yield of milk.

Helminthology

47. A new unusual helminths of some domestic animals in India.

G. D. BHALERAO, Mukteswar.

The parasites *Mesocestoides litteratus* from the intestine of a cat, *Parafilaria bovicola* from the subcutaneous tissue of cattle and *Dicotyocaulus filaria* from the bronchi of a buffalo have been recorded for the first time from this country. Interesting morphological observations are supplied in regard to the first two. The *Coenurus* of *Multiceps gaigeri* has been recorded from an unusual site, *viz.* the mucous membrane of the eye of a sheep. Interesting observations have been made on the grouping of the scolices on the cyst-wall and in regard to the nature of the hooks on the rostellum.

48. A brief review of the species of schistosomes of the domesticated animals in India and their molluscan hosts.

M. ANANT NARAYAN RAO, Madras.

The paper deals mainly on the species of schistosomes of domestic animals occurring in India. It has been emphasized that a detailed description of the adult parasite, its larval forms including miracidia and its molluscan host will go a long way to establish its identity. Enough attention has not been paid by workers in India with regard to some of the factors cited above, with the result that correct identification of species has been questioned.

In India seven species of schistosomes have been recorded, viz. S. bovis, S. spindalis, S. indicum, O. bomfordi, S. japonicum, S. nasalis and S. suis. The life-histories of S. bovis, S. spindalis, S. japonicum and S. nasalis are known, while those of the remaining ones have yet to be done. It has been pointed out that S. bovis and S. japonicum cannot exist in India, inasmuch as the concerned snails are absent in this country. Hence the worms recorded as such in India have been considered to be only S. indicum and S. suis respectively.

A fairly large number of larval trematodes has been recorded by Sewell and other workers and out of these, four are schistosome cercariæ. The adults of two of these have been reared by feeding experiments and found to be S. spindalis and S. nasalis. More work is to be done to identify the adults of the other larvæ also.

Whether schistosome cercariæ of animals in the waters of lakes and ponds used for bathing purposes have any part to play in the causation of cirrhosis of liver in man is a point worthy of consideration.

49. The importance and control of freshwater snails in veterinary research with special reference to work in Hyderabad State.

M. R. MAHAJAN, Hyderabad.

This paper is an attempt to stress the importance of the study of some freshwater snails in the dissemination of diseases caused by trematoda or flukes (helminths) with reference to animal infestation and measures required to control this intermediate host.

The flukes that infest animals in Hyderabad and the fresh water snails met with, together with the rediæ and cercariæ are recorded. Limnæa acuminata, Limnæa luteola and Indoplanorbis exustus are shown to be of importance in spreading Liver Fluke (Fasciola gigantica) and Schistosomiasis (Schistosoma nasalis).

Special mention is made of the favourable conditions prevailing for the development of snails in the area under the Nizamsagar canal in Nizambad district where Liver Fluke is responsible for serious loss.

Experimental measures adopted for the control of snails in a couple of villages have been of considerable value. These consisted of mechanical removal and chemical destruction with copper sulphate in the water-logged places occupied by snails.

These measures against the snail together with the treatment of affected animals with carbon tetrachloride or Igitol has controlled the mortality from Liver Fluke disease in the two villages.

50. Studies upon the morphology of the larval forms of *Hypoderma crossii.*

B. N. Soni, Mukteswar.

The young larvæ of *Hypoderma crossii*, which are pure white in colour and measure from 7·5 mm. to 10·5 mm. in length by 2 mm. to 4·5 mm. in breadth, possess on their ventral surface a double band of spines, on each segment, from the second to the ninth segments inclusive. On the dorsal surface there is a double band from the second to the fifth segments only, the sixth segment having a single band on the anterior border. The seventh to the tenth segments inclusive show no spines on the dorsal surface, the tenth segment being totally devoid of spines.

The full grown larvæ of *H. crossii* are barrel-shaped, cream-buff in colour and measure from 15·5 mm. to 17·5 mm. in length by 8 mm. to 9·5 mm. in greatest width. The ventral surface of the larva shows transverse bands of forwardly directed chitinous spines, on each segment, from the second to the eighth segments inclusive. No spines are visible on the dorsal surface of these larvæ.

The full grown larva of *H. crossii* may be differentiated from the larva of *H. lineatum* by the fact that the latter possesses transverse bands of spines on its ventral surface from the second to the tenth segments inclusive.

51. A preliminary report on intestinal paramphistomiasis of sheep in Sind.

H. S. Bawa, Karachi.

An outbreak of disease amongst sheep was investigated and it was found to be associated with immature forms of *Cotylophoron cotylophorum.* This disease occurs after rains, floods and in inundated areas. Symptoms are that of great unthriftiness, diarrhœa and swelling of sub-maxillary space, which attains its great prominence in the evening. The death rate is 80 to 90%. On *post-mortem* examination these numerous immature forms were found embedded in the mucus coat of small intestines setting up varying degree of inflammation and pin head hæmorrhages. The adipose tissue of whole carcase was changed into whitish cheese like structure. Pieces of duodenum and intestines showed lesions of *chronic verminous enteritis* on histopathological examination. There is no evidence to suspect that other helminths recovered were in any way connected in producing the disease. Drenching with 7 c.c. of carbon tetrachloride and 13 c.c. of sweet oil gave good results.

Biochemistry

52. Normal clinical standards of equine blood.

N. D. Kehar *and* Mohan Singh, Mukteswar.

A sound knowledge of the blood chemistry is absolutely essential for formulating a scientific basis in modern therapy. The significance of establishing normal clinical standards cannot therefore be over-emphasized. This paper deals with the protein fractions and several other constituents of the normal equine blood.

53. Daily variations in the serum protein fractions of buffaloes undergoing immunization by various methods against rinderpest and their relation to the potency of the serum.

R. L. Kaura, Mukteswar.

The estimations of the daily variations in the several fractions of serum protein, namely, albumin, euglobulin and pseudoglobulin, were made on buffaloes undergoing immunization by various methods against rinderpest. Prior to immunization, the normals were obtained over a period, and on the commencement of inoculation, the various fractions were estimated daily for a period extending up to 45 days. The estimations were done colorimetrically by Greenberg's method (1929) for which the necessary 'factors' for the various fractions of proteins present in buffalo serum were previously obtained by estimating them by Kjeldahl's and the colorimetric methods simultaneously. The various samples of serum, obtained at varying intervals, were tested on hill bulls.

In general the findings were:—

1. There was no appreciable difference as indicated by the potency of the serum and changes in the relevant serum-protein fractions, in the reaction to immunization with either bull or goat virus.
2. There was no definite correlation between the degree of clinical reaction and the potency of the serum.
3. Increase in the total proteins of the serum, which was mainly due to an increase in euglobulin and partly also in pseudoglobulin, was observed in some cases as early as the fourth or fifth day. This increase was maximal between the fourteenth and nineteenth day after immunization after which it gradually declined, with some fluctuations, to slightly above the average normal on the forty-fifth day.
4. Increase in these fractions of serum proteins was not proportionate to the increase in the potency of the serum.
5. The albumin content of the serum was not appreciably altered.

Vitaminosis

54. Observations on avitaminosis-A in farm animals and how it is brought about.

N. D. Kehar, Mukteswar.

Evidence is accumulating to show that there is a great prevalence of avitaminosis-A amongst the farm animals in India. Attempts have been made to study the effects of different methods of harvesting, drying and conserving, as practised by the average farmer in India on the Vitamin A contents of grasses and other fodder plants. It has been found that a considerable amount of carotene is destroyed during the process of sun curing. Such methods of hay making which would not cause any appreciable loss in the amount of carotene and minerals are discussed.

55. Deficiency diseases of animals in India.

K. C. Sen *and* N. K. Ayyar, Mukteswar.

A survey of the existing knowledge on the deficiency diseases prevalent amongst domestic animals in India has been made. The reports, both experimental and observational, on diseases such as abortion of non-specific type, congenital blindness in calves and ophthalmia in growing animals due to lack of Vitamin A have been reviewed. It has also been mentioned that due to the deficiency of phosphorus or calcium in the ration osteomalacia in ruminants or osteoporosis in equines is found in many parts and other disorders like milk fever, tuberculosis, Johne's disease, etc. tend to occur among milch cattle. Evidence has been produced to show that the incidence of these diseases has been effectively suppressed by supplementing minerals in the ration. The effect of unbalanced and protein deficient rations on parasitic invasion in the animal organism and general unthriftiness and functional disorders of nutritional origin have also been discussed.

Virus

56. Infectivity of eggs in Doyle's (Ranikhet) disease.

R. L. Kaura, Mukteswar.

A fully formed egg was collected from the cloaca of a hen that had died of experimental Doyle's disease infection. After thorough disinfection of the shell, a saline emulsion of the yolk was prepared and one c.c. was inoculated sub-cutaneously into a fowl which reacted mildly and on retest with our stock Doyle's disease virus was found to be immune. The same material which had kept in the refrigerator was inoculated into six more fowls. All of them reacted typically and five died.

57. Rinderpest in sheep and goats.

H. S. Bawa, Karachi.

The investigation into an outbreak of a contagious disease among sheep and goats was undertaken during April, 1938.

Microscopical examination of smears from heart, blood, lungs, spleen and liver of recently dead animals ruled out any possibility of the disease being *anthrax*, *hæmorrhagic septicæmia* and *piroplasmosis*. The clinical symptoms and post-mortem findings resembled in all its aspects to that of rinderpest seen in bovines, but the baffling thing was that cattle and buffaloes of the same and the adjoining villages were free from the disease. The mortality in these outbreaks was from 80 to 90%, and 1,712 sheep and goats died of the disease.

To confirm the diagnosis, blood sub-inoculations were carried out into a buffalo calf, calf, goat and sheep. The buffalo calf and calf reacted well and showed rise of temperature on fourth day. A piece of spleen removed from diseased sheep was sent to the Imperial Veterinary Research Institute, Mukteswar and disease was confirmed by them as rinderpest. Ulcers were seen on the gums and tongue in about twenty per cent. cases. The gastro-intestinal tract was severely ulcerated but in some cases it was only congested. The lungs of few animals showed pneumonic changes. The disease runs a definite seasonal course. The outbreaks generally start during March and continue till the monsoon sets in. The ordinary anti-rinderpest serum was used in doses varying from 5 to 10 c.c. for passive immunization, but results were not very satisfactory, especially in those cases where all the affected flocks of the villages were not protected. Goat Tissues Virus Vaccine with varying doses of anti-rinderpest serum was tried simultaneously in some animals and results were very encouraging.

58. A successful method of vaccination against goat-pox.

R. L. Kaura *and* S. Ganapathy Iyer, Mukteswar.

Research work in connection with the study of goat-pox virus and the evolution of a suitable method for prophylaxis has been in progress at this Institute for the last few years. It was found that goats could be successfully immunized with a vaccine prepared by desiccating the crusts over phosphoric anhydride *in vacuo* and emulsifying one part of it in a hundred parts of 50 per cent. neutral glycerinated saline. It is aged at room temperature (about 20°C.) for 7 days before use.

The vaccine is inoculated by scarification and such vaccinated goats can withstand a large dose of virulent passaged goat-pox virus.

59. Rinderpest in sheep in India.

R. L. Kaura, Mukteswar.

Recently materials from outbreaks amongst sheep occurring in the Bombay Presidency and Sind Province were received at this Institute for biological test. These were found to be positive for rinderpest. Reactions obtained in hill bulls with the above strains of the virus were unusually severe, with almost one hundred per cent. mortality, as compared with those obtained with our routine bull virus.

Although the occurrence of this disease in sheep has not so far received due attention in India, yet it seems to be of imminent danger to the incontact cattle especially on account of its exalted virulence.

60. Some observations on the viability of Doyle's (Ranikhet) disease virus of fowls under different conditions.

S. Ganapathy Iyer, Mukteswar.

The paper records the results of experiments conducted with reference to the viability of the virus under laboratory conditions as well as a review of the past literature on the subject.

The virus used for the different tests was mostly contained in organs such as liver and spleen. Doyle's disease virus after aging at Mukteswar room temperature (about 17°C.) remained viable for 21 days.

At 37°C. the virus did not die after 24 days but was inert after 31 days.

Saline emulsion of buccal swabs from fowls dead of experimental Doyle's disease gave disconcordant results. It remained viable at 37°C. for 3 days but was found to be dead after 4 days.

Exposure to direct sunlight for one hour had no lethal effect on the virus.

61. On the successful experimental transmission of variola in goats in a generalise form.

S. Ganapathy Iyer, Mukteswar.

The paper records the incidence of goat-pox lesions in a generalized form following the subcutaneous injection of materials such as spleen and blood from infected goats at the initial height of thermal reaction. The lesions in one case were confined to the external and internal parts of the buccal cavity, while in another case classical cutaneous lesions of Variola were demonstrable throughout the body, especially on the under surface of the abdomen and the inner side of the thighs.

62. Paralysis in a pigeon due to Doyle's (Ranikhet) disease.

S. Ganapathy Iyer, Mukteswar.

A natural case of Doyle's disease in a pigeon used for the preparation of fowl-pox vaccine was observed at the Imperial Veterinary Research Institute, Mukteswar. The characteristic symptom was the paralysis of wings and limbs as has been commonly encountered in our experimentally infected pigeons. It was confirmed by biological and cross immunity tests, using Seitz filtrates of spleen emulsion.

Natural cases of this disease in pigeons have not been recorded in India in the past.

63. Blood chemistry of normal and hæmaturia animals.

N. D. KEHAR, Mukteswar.

Very little is known about the blood chemistry of animals suffering from hæmaturia. A detailed investigation was undertaken into the various constituents of the bovine blood as a possible aid in elucidating the evidence already available. Observations made so far indicate that total globulin, euglobulin, sugar, cholesterol and lecithin are much less in the hæmaturia cows compared to the control.

64. The association of aphosphoresis with contagious equine abortion.

N. D. KEHAR, Mukteswar.

The problem of equine abortion is of great practical importance. Investigations into the blood chemistry of aborted mares showed that the inorganic phosphorus content was significantly low. It was also interesting to observe that most of the cases which had low serum phosphorus were found positive for *S. abortus equi* infection.

SECTION OF AGRICULTURE

President :—RAO SAHIB T. V. RAMAKRISHNA AYYAR, B.A., Ph.D.

Agronomy

1. Note on the tolerance of different types of cotton to alkaline soils in Sind.

B. B. MULCHANDANI, Sind.

Sind Deshi cotton types belonging to *Gossypium neglectum* were tried against Punjab American cottons of *Gossypium hirsutum* in eleven replications at Government Experimental Farm, Mirpurkhas, East Sind, in 1923-24, in alkaline soil locally known as 'Kalar'. Their germination was good but the final number of plants at the time of picking varied owing to the degree of tolerance of each variety to alkaline conditions. The Deshi types 27 W.N., 30 W.N. and Jamrao Deshi having 72·0, 66·7 and 65·5 per cent. stand of plants were significantly better than Punjab American types 285F with 47·6 per cent. and 4F with 37·5 per cent. stand.

At Sakrand, middle Sind, also Sind Deshi (*Gossypium neglectum*) type gave best stand 84·0 per cent. in 'Kalar' soil in 1926. The relative figures for Punjab American (*Gossypium hirsutum*), Upland American (*Gossypium hirsutum*) and Egyptian (*Gossypium barbadense*) types were 69·7, 51·8 and 22·4 per cent.

2. Effect of soaking on germination of cotton seed.

B. B. MULCHANDANI, Sind.

Parbhani American (*G. hirsutum*) cotton seed has got about 13% fuzz over the seed coat. It was soaked for 12, 24, 36, 48, 60, 72, 84 and 96 hours and sown along with dry seed as control in seven replications at the Government Experimental Farm, Parbhani (Deccan) in H.E.H. The Nizam's Dominions, in typical black cotton soil under the field conditions.

The seed soaked for 12, 24 and 36 hours gave better germination than unsoaked seed, and with the increase in the time of soaking there was corresponding decrease in the germination, the behaviour of the over-soaked seed being worse than unsoaked seed.

The seed soaked for 72 hours or more took greater time to germinate than the dry seed. Quickest germination was obtained from the seed soaked for 12, 24 and 36 hours.

The cotton seed when immersed in water for 12 to 24 hours is fully viable and with the increase in the time of soaking there was decrease in the viability of seed which after 96 hours ran down to about 25%.

3. T.E.B. 1, an alkali-resistant strain of paddy for Nanjinad.

N. K. B. KURUPP, Travancore.

An account of a newly evolved strain of paddy (T.E.B. 1) for the alkaline fields in Travancore is given here with essential details. The strain is not only alkali-resistant, but is also a high-yielder, giving about

3,000 lbs. to 4,000 lbs. of grain-yield per acre. The straw-yield is also very good. This strain is suited for cultivation in the alkaline fields in South Travancore, where no less than ten thousand acres of alkaline fields are now left uncultivated, because of the injurious nature of the salts contained in the soil.

4. Varieties of mangoes cultivated in Travancore.

N. K. B. Kurupp, Travancore.

The paper gives a short account of the important indigenous and exotic varieties of mangoes cultivated in Travancore. The introductory paragraphs clearly show the present position of fruit culture in the State. The important varieties of mangoes about which descriptions are given in the paper are:—

Karappukáchi, Kallu-varikka, Kola, Vázhapo͞o, Thyrukáchi, Karuppu-Katty-káchi, Che͞eni-káchi, Sarkara-káchi, Manja-káchi, Kappakáchi, Náttukóla, Pothakáchi, Vella-káchi, Kandánki, Pávakkáchi, Palavakkáchi, Pacharisi, Théngákkáchi, Karpo͞oramávu, Sámprány mávu, Pulippukkáchi, Urundakkáchi, Vazhakkáchi, Mulgoa, Banglora, Kalapádi and Sundersha.

5. *Ipomœa hispida*, Roem and Sch., a useful fodder weed.

G. N. Rangaswami Ayyangar, Coimbatore.

Ipomœa hispida, Roem and Sch. is a weed commonly occurring in fields of horsegram (*Dolichos biflorus*, Linn.). This weed has proved to be a valuable fodder plant that is drought resistant. Cattle relish the fodder. The vines and seeds, on analyses show to be rich in fodder and food value. Acre yields up to 4,000 lbs. could be obtained. A botanical description of the weed is given. Its utility against soil wash is indicated. This weed deserves greater attention and a wider trial.

6. Some observations on rice seed-testing.

H. K. Nandi *and* P. M. Ganguli, Assam.

The present paper reports a comparative study on the germination capacity of rice seeds under different conditions. The indications are:—(i) that rice grains, though they germinate in water, cannot stand it for further growth; (ii) that rice seeds germinate well under mud to a depth of 1·2 inches but can hardly make their way out from beyond the depth of 2″; the seeds may remain dormant under the depth of 10″ of mud for two years and may germinate again when taken out; (iii) seeds kept in air-tight containers keep their germinating capacity much longer, than when kept in open air; (iv) that the viability of seeds treated with 2% and 4% formalin is not affected up to a certain period; the decrease in the percentage of germination corresponds with the increase in the strength of the solution and period of treatment; (v) that germination per cent. decreases in proportion to the quantity of CS_2 and period of treatment; (vi) that 15 gms. of seed are not affected by 5 gms. of naphthalene, while further increase in the quantity of naphthalene proves harmful; (vii) that rice seeds do not germinate in brine, but when taken out and washed they do not show any sign of deterioration till the 28th day, after which the germination per cent. decreases slowly and becomes nil on the 56th day; (viii) that the highest per cent. and quickest germination are obtained by soaking rice seeds for 12 hours; (ix) that seeds stored in galvanized iron bins keep up their viability better than those stored in gunny bags.

7. Studies on the metabolism and growth of Malta oranges.

J. C. LUTHRA *and* I. S. CHIMA, Lyallpur.

It is recognized that physiological studies are important for determination of the length of time for which the fruits can be stored without any adverse biochemical changes. The paper describes results of an investigation made on the metabolism and growth of malta oranges. It is interesting to note that the respiratory activity gradually slows down from adolescence to maturity despite the accumulation of carbohydrates. The respiratory activity shows a second high value at the climacteric stage and this is exactly in line with the results of other workers. The relative growth rate and nitrogen contents of the developing fruits show strict concomitance with respiratory activity and statistically a very high positive correlation has been found to exist between these. Reducing sugars, sucrose and total sugars steadily increase from adolescence to maturity. The reducing sugars are highest just before the climacteric rise in respiration. At no stage of the development of fruits starch formation could be noticed either in the flesh or skin of the fruit. The total titratable acids have been found to increase gradually till 170th day, but fall down later on. The total solids are highest in the beginning when the fruit is young, but later on decrease on account of the progressive hydration, which follows subsequently.

8. Variations in the concentration of juice in sugarcane.

P. V. RAMIAH *and* T. VARAHALU, Coimbatore.

The changes in concentration of sap of sugarcane over its entire length from its growing point down to its bottom were followed with the aid of a hand refractometer. The canes selected were of ages, 5, 5½, 6 and 10 months. They include canes which are: (i) unarrowed, (ii) arrowed, (iii) which are in shot blade and (iv) those which are treated with and without manure. For purposes of this study three distinct regions were distinguished at the nodal parts. They are: (i) intercalary meristem (growth ring), (ii) Keimring (bud and root primordia) and (iii) leaf sheath insertion zone (leaf sear).

2. The distribution and the mode of accumulation of sugar in the juice during the development of cane towards its maturity, follow a regular sequence which is interesting from the point of view of the physiology of sugarcane.

3. The forms of concentration curves and the character of the changes in form which they undergo are similar in all cases, whether the cane is arrowed or unarrowed, manured or unmanured, or whether it is only in shot blade.

4. The concentration of juice is not strictly uniform, either in the whole cane or in any of its internodes. But as the cane matures, the differences in the average concentrations in successive internodes in the older parts of the cane, tend to get considerably narrowed down.

5. In the internodes, beyond certain stages in their development, there occur maximum concentration about their central parts, and two minima, one at either end of each internode. One of the two minima corresponds to the intercalary meristematic zone at the base of the internode, and the other to the zone of leaf sheath insertion at its top. The former is the lower of the two minima.

6. In a young cane and in the younger parts of a developed cane, the concentrations at all points within an internode are lower than those in the Keim ring and the leaf sheath insertion zones. The concentration curves are troughs lying below the levels of the nodal concentrations.

7. But with advance in age, the concentration in both the nodes and the internodes gradually increases. Those in the nodes all tend to become equal and attain a stationary level. Within any internode, the

concentrations at all points in it gradually increase beyond those in the nodes, and continue to do so, such that, in time, the forms of their curves get completely inverted: they change their shapes from troughs lying entirely below the levels of the nodal concentrations to bell shaped ones with every point on them being far above the concentrations in the nodes. The rate of this change, however, varies from point to point in the internode. The change is very gradual and commences earlier at the top of the internode. All the possible intermediate transitional stages through which the curves pass in the process leading to the complete and the final inversion of the curves are illustrated.

8. Taking the cane as a whole, the concentration in it commences to increase earlier at its bottom but taking each internode in it individually, the increase occurs earlier at its top. With advance in age, the concentration in both gets to be maximum in the central parts.

9. Manuring seems to keep the cane physiologically much younger than the one which is of equal age, but which receives no manure.

9. Crop response to winter cultivation in Malwa.

G. C. Tambe *and* G. K. Sant, Indore.

Cold weather cultivation for rain-fed crops is usually not practised in Malwa. From 1933 to 1937 a randomized and replicated field experiment was carried out on a field of medium fertility at the Institute Farm. Four other systems of cultivation were compared with the local, no-cultivation, method. A rotation of jowar, groundnut, cotton and wheat was adopted, the treatments being given before groundnut and before cotton. An estimate was made of the direct effects of these treatments on cotton and groundnut and of the residual effects on wheat and jowar. The treatments were so designed as to bring about differences in the degree of exposure of the field soil, which was opened to different depths or made loose in the lower depths only by sub-soiling or its lower layers were brought to the surface by inversion. The crop yields were for the most part not affected by these treatments.

Soils, fertilizers and manures

10. Variations in the properties of hydrogen clays obtained from different clay subfractions of Indian soils.

R. P. Mitra *and* S. Chakravarty, Calcutta.

A comparative study has been made of (i) the chemical composition, (ii) the nature of the potentiometric titration curves with different bases and (iii) the base combining capacities calculated from these curves of hydrogen clays obtained from different subfractions of the entire clay fraction of a laterite soil from Bengal and a black cotton soil from Akola (C.P.). The chemical compositions of the hydrogen clays obtained from the different subfractions of either soil determined by fusion analysis were different. With decreasing particle size the percentage of sesquioxides rapidly increased while that of silica, decreased. Titration of a given hydrogen clay with different bases yielded different base combining capacities at the same *p*H. The base combining capacities decreased in the order: $Ca(OH)_2 > Ba(OH)_2 > NaOH$. Using hydrogen clays from the different subfractions of either soil, the smaller the particle size the greater was the base combining capacity with a given base though no exact correlation was found to exist between the base combining capacity and the specific surface calculated assuming spherical particles. The amounts of free H ions associated with given weights of the colloidal material also rapidly increased with decreasing particle size. These amounts were calculated from the observed *p*H values of the corresponding hydrogen clay sols. The ratio of free to total (*i.e.*, titratable) H ions also increased though even with the smallest particles the ratio was as low as 0·05, indicating a large preponderance of osmotically inactive over osmotically active H ions in the double layers associated with the hydrogen clay particles. Further work with clay subfractions from other soils is in progress.

11. On the nature of the red soils of Chota Nagpur Range and of Orissa.

S. P. Raychaudhuri, Dacca.

Red soils occur in plenty in Chota Nagpur and in Orissa. Profiles of red soils were collected from Kapilas Road, Dhanmandal, Bhubaneswar and Khurda Town, through the kindness of the Director of Development, Orissa. Through the kind help of the Director of Agriculture, Bihar, typical profiles of red soils from the following districts of Bihar province were also collected: Manbhum, Singhbhum, Ranchi and Palamau. Considerable gully and sheet erosion was noticeable in both provinces. In general, red soils were found to exist on the higher slopes of the hills, brownish soil at intermediate layers and greyish black soil lower down. The general morphology of these soil profiles suggests that the red soils of Chota Nagpur are of the nature of red earth or red loam while those of Orissa fall into two categories: (*a*) Vesicular rocky mass commonly known as '*Laterite rock*'; and (*b*) Nodular gritty mass commonly known as '*Laterite murrum*'.

The physio-chemical properties of soil samples at different layers of these profiles are being determined.

12. Studies on base-exchange reactions and lime-requirements of some Indian lateritic soils.

S. P. Raychaudhuri *and* A. B. Nandy Mazumdar, Dacca.

Base exchange properties such as the content of total exchangeable bases, the saturation capacity and the percentage of exchangeable calcium as well as the nature of buffer curves of a considerable number of red soils of India have been studied on a profile basis. From these studies it has been possible to classify these red soils into four groups.

13. Influence of saturation with lime at *p*H 7·1 on some general physical properties of lateritic soils in relation to the Keen-Raczkowski box experiment.

S. P. Raychaudhuri *and* A. B. Nandy Mazumdar, Dacca.

A number of red soils of India, collected on the profile basis, were treated with half neutralized *p*-nitrophenol calcium buffer of *p*H 7·1 until the soils were saturated with lime. The soils were subsequently freed from adhering salts. The following properties of these soils before and after treatment with the lime buffer were compared:—(*a*) Apparent sp. gr.; (*b*) per cent. pore space; (*c*) true sp. gravity; (*d*) Maximum water-holding capacity; (*e*) maximum xylene-holding capacity; (*f*) per cent. volume expansion; and (*g*) per cent. imbibitional water. It was found that, in general, the per cent. pore space, volume expansion in 100 c.c., maximum water-holding capacity and maximum xylene-holding capacity of the soils increased on saturation with lime. This is in accordance with the general observation that the texture of a soil, in its relation to plant growth, is generally improved on saturating the soil with lime. The per cent. of imbibitional moisture holding capacity, however, does not show such general behaviour.

14. On the ferrous iron content of Indian soils.

U. P. Basu *and* H. Goswami, Calcutta.

It has now been definitely established that a deficiency in iron leads to nutritional and hypochromic anæmias with consequent loss of health and economic efficiency. We, for our physiological well-being, generally get iron from our foodstuffs, the iron content of which depends much on the amount of soluble iron present in the soil upon which the plants have been grown. It would, therefore, be of interest to have a knowledge on the soluble iron content of any soil. But as the ferric oxide present in any soil, by its action with the organic matter in the soil, is generally reduced to ferrous compounds (carbonates) which being soluble in soil water rich in carbon dioxide is redistributed partly to plants, so it would, naturally, be a reasonable guide to know only the amount of ferrous salt present in any soil in assaying its soluble iron content. Recently dipyridyl has been found to be a reliable reagent in the estimation of ferrous salt present in any biological material, as this reagent readily forms a stable coloured compound with a ferrous salt within the range of certain *p*H. Accordingly, samples of soil collected from local cultivated lands, were first of all analysed for the total iron and moisture contents, and then they were suspended in aluminium chloride solution (2%) in amber coloured bottles and left over in dark. The clear surface water gave no immediate colour reaction with dipyridyl but within 3 to 4 days the colour began to develop and gradually increased with the period of time. In finding out the amount of ferrous salt in the solution an aliquot part of it was taken and treated with dipyridyl solution in presence of hydroquinone, the *p*H of the mixture being maintained at about 4·5. The coloured solution was then left aside in darkness for about half an hour and then compared with standards in a Klett colorimeter. The addition of hydroquinone does not materially increase the ferrous iron content. A particular sample on analysis gave the following results: total iron, 2·58%; moisture, 8·65%; ferrous iron after 2 weeks 3·56 mg. per 100 gms. of the soil (moist) and this after 7 weeks 5·84 mg. The work is in progress to find out the ferrous iron content of the soil from different experimental farms to be kindly supplied by the Director of the Imperial Agricultural Research Institute, New Delhi.

15. Effects of alphos on sugarcane grown in an acid soil.

H. N. Pal, Jorhat.

The paper records how *alphos*, a mineral phosphate, influenced sugarcane crop grown in the acid soil of the Jorhat Farm (Assam). For this purpose the results of two manurial experiments, one with plant canes and the other with ratoon canes of POJ. 2714, conducted at the Jorhat Farm during years 1936-37 and 1937-38, respectively, are discussed.

By confining attention only to phosphatic applications in these experiments, *viz.*, 'no alphos', 200 lbs. alphos, and 300 lbs. alphos per acre, and by combining two years' results, it was apparent that 200 lbs. alphos produced an increase of 1·06 tons of stripped canes per acre over 'no alphos' in the 1st year, and the increase in the 2nd year was 1·6 tons per acre. The corresponding increases produced by 300 lbs. alphos over 'no alphos' were 1·36 tons and 2·36 tons per acre respectively. It was thus evident that alphos, under the conditions of these experiments, underwent changes which slowly but increasingly influenced the yields of POJ. 2714. As for its influence on juice, 'no alphos' gave the best juice in both the experiments in comparison with the phosphatic applications, but the yields of canes were much more influenced than juice.

16. Studies in soil fertility. Part II.

A. L. Sundara Rao, Bangalore.

In continuation of his work on soil fertility studies (*Proc. Indian Science Congress*, 1938) the author has undertaken a systematic examination of the cellulose decomposition in soil and the consequent nitrogen fixation.

Press mud (which contains 38–40% carbon in the form of fine particles of bagacillo) has been used as the cellulose rich material and the nitrogen fixation studied in pot and field experiments. The temperatures of the soils receiving these treatments were recorded at regular intervals.

It was observed that application of Press mud besides enriching the soil with the nitrogen, phosphates and lime that it contains is able to fix atmospheric nitrogen. The influence of light absorption on this process has also been studied.

17. Studies in soil fertility. Part III.

A. L. Sundara Rao, Bangalore.

In the course of his field experiments on the fertilizing value of Press mud, the author has observed that exposure to light enhances to a considerable extent the amounts of nitrogen fixed per gram of energy material oxidized.

To test whether these conclusions will hold good in artificial bulb light, which excludes most of the ultra-violet rays, experiments were undertaken in dishes with mixtures of soil and sugars (*e.g.*, glucose and cane sugar). These were exposed daily for 10 hrs. to light from a 1,000 Watt lamp and the changes in carbon and nitrogen were followed at regular intervals.

The observations recorded previously that the nitrogen fixation taking place on the addition of energy rich substances to soil is enhanced when the system is exposed to light have been confirmed. The region which is effective in bringing about the increase in fixation has been established (*Curr. Sci.*, August 1938).

Further experiments to show the real significance of light of different wavelengths on nonsymbiotic fixation of nitrogen are in progress.

Agricultural Botany

18. Certain suggested floral characters for distinguishing commercial sugarcane varieties.

N. L. Dutt, Coimbatore.

A character has been noticed which has perhaps not so far been recorded in sugarcane. It is the presence in certain varieties, of a rudimentary third style with stigmatic papillæ. It was first noticed in Co. 421 and also in a few other varieties, but when present, is apparently characteristic of the variety. The size of the spikelet would appear to be another useful character. The spikelet of Co. 421 is about 1 mm. longer than that of Co. 419.

Curiously, such an important character as the opening first of the pedicelled or the sessile spikelet, which is of taxonomic value for distinguishing species of Saccharum does not appear to be helpful for demarcating one variety from another. An awned IV glume has been found to be often present in some varieties and may be taken as a reliable criterion for distinguishing varieties. The palea may not be quite so helpful but in certain varieties it shows a tendency to deep foring which is fairly characteristic.

It is suggested that when coupled with the vegetative characters that are now usually adopted for describing sugarcane varieties, the above floral characters will serve as useful additional characters for identification.

19. The behaviour and utility of three big bracts surrounding a flower.

V. N. Ranganatha Rao, Mysore.

It is argued that while the presence of bracts is not advantageous to the plant, as they get mixed when dried with seed cotton at the time of harvest, they may, on the other hand, be useful functioning as leaves and thus contribute towards nutrition of the fruit. On the above basis new varieties are being developed possessing big bracts which may help towards the photosynthesis and at the same time flaring away from the fruit to admit clean picking of cotton.

20. Root studies of sugarcane in different types of soil under field conditions.

B. K. Dhar, Assam.

The two varieties of sugarcane, *viz.*, POJ. 2714 and Co. 290 show differences in their root activities when treated under different soil conditions and under different treatments. When the setts are planted in trenches with farmyard manure the root systems are found to be spreading in different directions at the early stage of their growth. But in pits the root systems though more in number appear to be more or less in bunches and the growth of the cane is not so vigorous as found in trenches. The growth rate of the roots as well as the plants are more prominent up to the end of October, *i.e.* up to the end of the rain when the canes are about 6-7 months old.

Due to the high percentage of humidity in a place like Jorhat in the province of Assam, it has been found that in both the varieties specially in POJ. 2714, the sett roots on many occasions come out even before the actual planting of the setts in the field. It is also noticed that up to the end of the second month, the sett roots though finer than the shoot roots are quite active but later on they become inactive and are replaced by the shoot roots and ultimately disappear by the end of the third month. When the shoot roots however fail to develop, the sett roots penetrate and grow to a greater depth than normal and function like the shoot roots.

The soft cream colour shoot roots are very succulent at the very early stage of their growth and come out from the root zone of the newly grown main shoots as well as from the tillers from second month onwards and gradually their number and size increase with the advancing age of the plant and become comparatively hardy.

In sandy soils, the individual main roots are bigger in size and at the same time the depth of penetration is maximum. The canes mature a bit earlier in comparison with the canes grown in other types of soil, *viz.*, clay, clay-loam and sandy loam.

The total number of roots is greater when farmyard manure is applied, but the depth of penetration is less, whereas in the absence of farmyard manure the number of roots is less but the depth of penetration is greater.

In cases where there is no earthing, the roots that come out from the root zones of the growing main shoots and tillers soon dry up as they cannot come in contact with the soil and thus the growth is checked partially; whereas in the case of earthing once or twice, the successive developments of roots increase, which are correlated with the growth of the shoots and tillers.

In an inundated area in sandy soil when the canes are suddenly affected by flood and the water stands in the plot for about 15–18 days, the bottom of the growing main shoots and tillers below the earth is found decaying. But as soon as the flood subsides and the canes are earthed, fresh flush of roots comes out from the fresh portion of the main shoots and tillers and the plants regain their normal growth.

21. The effect of environmental and genetical factors on fibre maturity of cotton.

A. N. GULATI *and* N. AHMAD.

Changes in plant characters are either environmental or genetical in origin. To what extent each of these modifies fibre maturity of cotton is the subject of the present investigation, for which suitable material was obtained from five well-designed experiments laid out at the Institute of Plant Industry, Indore. Samples from only two of these experiments have so far been tested, while work is in progress on the remaining material. The results obtained have yielded the following conclusions.

A. *Agronomical factors* in regard to P.A. 289F and *Mollisoni* :—

1. Out of the two sowing periods, May suited P.A. 289F, while June helped *Mollisoni* to attain their best fibre—maturity percentages.
2. Preparatory cultivation consisting of fallow in *Kharif* and wheat in *Rabi* repeated over two years proved beneficial only to the fibre-maturity of P.A. 289F, while *Mollisoni* did well without this treatment.
3. *Heavy irrigation*, comprising eleven waterings as compared to *moderate irrigation* of six waterings, was helpful in raising the fibre-maturity of both cottons. *Mollisoni*, however, did equally well with moderate irrigation in the absence of preparatory cultivation.
4. The fibre-maturity of P.A. 289F was benefited by the application of '*Nicifos*' more than 'cake' or no-manure, while *Mollisoni* responded to 'cake' better than '*Nicifos*' or no-manure.
5. Single spacing as opposed to double spacing improved the maturity of both cottons.

B. *Hybridization factors* in relation to three parent varieties—Malvi, Bani and Cwn 520 and their three F_1 crosses.

1. Mean fibre-maturity of the hybrids showed positive improvement or heterosis over those of the parents.
2. Variance due to variety was found significant for 100 : 1 odds, while that due to blocks, plots and plants was non-significant.

22. Some studies on the potentiality of imperfectly developed wheat grains.

J. C. LUTHRA *and* I. S. CHIMA, Lyallpur.

1. The prevalence of hot and dry winds during development retards the growth in size of the grain and causes its desiccation with the result that it gets shrivelled. Hence there is a decline in yield. The grain is much reduced in size and is deficient in food store.
2. It has been substantiated by experiments that germination power and suitability of shrivelled grains for sowing are not affected.
3. The progeny plants of shrivelled grains lag behind the plump grains in growth in early stages of development, but the initial differences disappear at a later period. Ultimately shrivelled grains produce as good a crop as obtained from plump, normal grains.
4. The seedlings produced by shrivelled grains are metabolically less active as compared with plump grain and lag behind considerably throughout the germination period.

5. The initial lower weight and smaller size of the shrivelled grain do not operate adversely on the subsequent process of growth and yield of the crop.
6. The shrivelled grains produce a normal crop of well developed grains. The progeny grains show an increase of 212·2 per cent. in weight over the parent shrivelled grains.
7. It is shown that there is no advantage in grading wheat in order to get increased yield in the produce of a pure line.

23. Shedding of buds, flowers and bolls of cotton in relation to environment and cultural factors.

SHAMSHER SINGH *and* G. K. SANT, Indore.

During 1932 and 1933 seven randomized and replicated agronomic experiments with Mollisoni and P. 289F varieties of cotton were carried out on the State Farm in the Gang canal colony, Bikaner State. Periodic observations were taken on the number of buds, flowers and unripe bolls shed. A study was made of the effect (i) of meteriological factors, (ii) of the differences in irrigation frequencies, (iii) of sowing dates and (iv) preparatory cultivation, as well as (v) of the application of compost and (vi) different methods of green manuring with *Sann* (Crotalaria juncea) and Guara (Cyamopsis species).

The results have been examined to ascertain whether the extent of shedding for the whole or part of the season was correlated with the yields obtained.

Crop pests and diseases

24. Sugarcane borers and their control in the Mysore State.

T. V. SUBRAMANIAM, Bangalore.

Since the advent of the Mysore Sugar Company Factory at Mandya, large areas are grown under sugarcane in the Irwin Canal tract. The total area sown under cane annually comes to about 10,000 acres. Canes of all stages of growth are found throughout the year and the various borers breed in canes continuously. It has been the experience here that once the borer attack in the early stages of cane growth, *i.e.* upto about 3 months is prevented, the canes are able to grow very well and at least two of the most dreaded of the moth borers are unable to do any appreciable damage. The most important of the borers which cause the greatest amount of damage to young canes are the moth borers and they may be classed as '*dead heart*' borers and '*top shoot*' borers according to the nature of their injury. *Argyria sticticraspis* Hmp. and *Diatræa Venosata* Wlk. come under the first category and *Scirpophoga nivella* F and S. *monostigma* Zell. under the second. Other borers of minor importance are *Sesamia inferens* Wlk. and S. uniformis Ddgn. being shoot and stem borers and *Emmalocera depressella* Swinh. the root borer. This paper discusses the rôle of these borers, the nature and extent of damage caused to the crop by each of these and the control measures tried in Mysore with the results obtained so far.

Severe infestation of dead heart borers in the early stages of cane growth has caused large areas of cane to be completely ploughed and re-planted. In the case of the top shoot borers, which attack the canes when 4 months old, all further growth is stopped and the tonnage at harvest is greatly affected. The most important of the control measures adopted against the '*dead heart*' borers are (1) cultural method and (2) the biological method. The cultural method of control consists in giving a light earthing up by means of light mould board plough on both sides of the rows of cane when the shoots are about a month old. An irrigation is also given soon after. The young larvæ in the leaf sheaths are smothered and killed and the older larvæ in some of the stems showing dead hearts are unable to come out of the mass of soil to damage fresh shoots. The biological method is the mass production and utilization of the wasp *Trichogramma minutum Riley*, the egg parasite of the 'dead heart' borer and its release in cane areas. A parasite laboratory was established in the heart of the cane area three years ago. 8¼ million parasites were reared out in this laboratory in 1936-37 and 23 millions in 1937-38. In 1936-37 over 4 million parasites were released in about 200 acres of young cane fields, the rest being utilized for further breeding. In 1937-38, 10½ million parasites were released over 600 acres of cane. The laboratory equipment, etc. are enough now to produce parasites to cover 1,000 acres of cane per year. Results of preliminary experiments conducted in Government Farm gave an increase of from 5 to 8 tons more of cane per acre from the parasite released areas. Other results obtained are given.

The control methods adopted for the 'top shoot' borers are (1) The systematic hand picking of the conspicuous white moths and egg masses by gangs of children in the cane areas and (2) the regular collection and release in the fields of the natural parasites which emerge out of the masses of eggs collected weekly.

Some notes are also added on the natural enemies noted so far on these borers, *viz.*, on the *Dead heart borer eggs* a species of Telenomus in addition to *Trichogramma minutum* Riley. On the larvæ *Apanteles flavipes* Cam. and a *Tachinid* fly probably *Winthemia sp.* On *Top shoot borers Tetrastichus* sp. and to a very small extent *Trichogramma minutum* Riley or eggs. The larvæ are parasitized by:—

Elasmus zhntneri Ferr.,
Bracon famulus Bingham., and
Rhaconotus scirpophage Wilk.

25. A new and simple contrivance for pohli (Carthamus Oxyacantha) eradication called 'Darshan Pohli Maru Datri'.

DARSHAN SINGH *and* NEK ALAM, Punjab.

In the Punjab regular campaigns are organized every year for the destruction of pohli during certain fixed weeks known as 'Pohli weeks', and all forces in a district, where such campaigns are organized, are mobilized for this purpose. The tremendous harm this weed does to the crops and the importance attached to this work can be imagined from the necessity of organizing such vigorous campaigns. It is eradicated by means of ordinary sickle and khurpa, but as this plant is thorny and difficult to touch with naked hands, the use of these implements is restricted to certain limitations. Further these can only be used by squatting on hunkers, which is not only difficult, but becomes impossible in some cases due to the thorns. To overcome this difficulty, the writers have evolved a device by means of which this obnoxious plant (Pohli) can be eradicated without the necessity of squatting on hunkers. This implement is used while standing by swing method, and the oscillating force is sufficient to cut 4 to 6 plants per stroke without exerting much force. When working with this device, one is not required to handle the thorny plants at any stage. On account of its cheapness, usefulness and efficiency thousands have been made in the Gurdaspur circle. It costs 5 as. to make one, and its output is at least 4 times as that of the ordinary sickle.

26. The locust (*Schistocera*) with reference to Sind and Rajputana desert plants.

D. BHATIA, Burma.

Observations on the food plant of *Schistocerca gregaria* hoppers of the solitary phase were made in cages as well as in nature. It was noted that 'Ak' (*Calatropis gigantiea*) and Neem (*Azadi-rachta indica*) leaves were not eaten. The ovules of the former were, however, taken. Practically all the cultivated plants and some wild plants were readily eaten while others were only slightly liked, some only under stress of starvation. When a number of food plants are available certain particular species are preferred to others. However, if the plants preferred best are not in a succulent condition they may be discarded in favour of the ordinarily less liked fresh plants. It is suggested that localization of the preferred plants might lead to concentrations of locust adults and hoppers.

27. The role of food and its constituents on the productivity and longevity of the cotton stem weevil (*Pempheres affinis* FST.) of South India.

P. N. Krishna Ayyar *and* V. Margabandhu, Coimbatore.

The present paper is an attempt to throw some light on the nutritional physiology of insects with particular reference to the Cotton Stem Weevil —*Pempheres affinis* Fst. It is being increasingly recognized that studies on insect dietetics are of great practical importance in affording clues for devising preventive and control measures. Little is known regarding the physiological reactions of adult insects in relation to the character and composition of food, particularly coleopterous insects. A series of experiments has been described to determine the effects of different kinds of food on the fecundity and longevity of *Pempheres* females, under known and identical physical conditions. A convenient method of obtaining accurate oviposition records is given. Tables are presented recording the results obtained in respect of each kind of food namely—sucrose, molasses, jaggery, sugar, honey-solution, raisin, etc. Considerable variation is seen to be produced by differences in food. Mere supply of water does not seem to have any beneficial effect on its life duration or reproductive powers. An exclusive carbohydrate diet is noted to produce a remarkable increase not only in longevity but also in fecundity. Honey with its slight protein content has shown an increase, though small, in maximum egg capacity. Raisin with a proportion of proteins and fats besides carbohydrates has yielded the best results. It seems to constitute a complete food in respect of all activities inclusive of fecundity, fertility and longevity. From an average of about 4 eggs without any food, as high an average as 75·3 eggs per female with a record maximum of 157 eggs has been obtained on a diet of raisin.

Results of a few experiments to test the ovipositional responses with particular reference to oviposition-sites are also presented. Oviposition is seen to be generally poor in roots, buds, bolls, etc. accompanied by a great reduction in the general life-span of females. The data presented seem to suggest that the necessary food and stimulus are not obtainable from such sites.

28. Some non-insect pests and insectivorous animals of agricultural importance in S. India.

T. V. Ramakrishna Ayyar, Coimbatore.

Though the great majority of the pests affecting cultivated and stored agricultural products are insects, there are occasionally found other animal pests which are not however insects. The crop pest investigator who is usually the Entomologist has now and then to deal with such pests also. These belong to different groups of animals such as Worms, Mollusca, Crustacea, Arachnida, Myriapoda, etc. among lower animals, and fishes, rodents, some birds and even quadrupeds like elephants, jackals, wild pigs and monkeys among higher animals. A brief account is given in this paper of such of these forms noted to be of importance in S. India. These include chiefly Eel worms, snails, slugs, crabs, Mites, Millipedes and the estuary eel, and rats. A few words are also added on some animals which are useful to the farmer as insectivorous forms such as birds, reptiles, etc. with suggestions regarding the control of the pests and the utilization of the useful animals.

29. Biological notes on insect pests of young graft mango plants in Cochin.

C. S. VENKITASUBBAN *and* A. NEELAKANTA IYER, Cochin.

There has been a great extension of the cultivation of the graft mango in Cochin in recent years, as a result of the propaganda by the Agricultural Department in the State. But insect pests are a serious problem which every grower has invariably to contend with for the first two to three years of the plant's growth. The severest ones are *Deporaus marginatus* Pasc. *var.*, and a new species of Cecidomydæ, *Rhabdophaga mangiferæ* Mani. *Deporaus* sp. weevils are present throughout the year, and there is a sort of persistence in the affection in that every whorl of leaves successively put forth by the plants is cut away by the pests reducing the plants to mere stems. Details of life history worked out are given.

The Cecidomyid fly *Rhabdophags mangiferæ* Mani, which has been described as a new species by M. S. Mani, is widely distributed throughout the State. The flies produce galls on the petioles, mid-rib, and veins of the tender leaves. The whorl of leaves shrivel and dry up as a result of the attack. This fly is also present throughout the year. Details of life history are given.

Next in importance to these two insects, come caterpillars of the moth *Thalssodes* sp. and *Mylloceruss* sp. of weevils. Details are given of how these two pests are responsible for a good deal of defoliation of young plants.

On account of these insect infestations, the problem of steering the plants through the initial two or three years of their growth is a difficult one for the grower to overcome.

30. Trials with the insectide from 'Derris elliptica' plant cultivated in Cochin.

C. S. VENKITASUBBAN, Cochin.

The paper details the results of an experimental cultivation of '*Derris elliptica*' in the Cochin State Central Farm, Trichur. Cuttings were obtained from the Agricultural Officer, Singapore, S.S. & F.M.S., in May, 1935 and planted in pots. After they had sprouted well, the cuttings were transplanted into beds in the field on 2-1-36. Growth and development were very satisfactory and the crop was harvested on 31-5-37. The roots, after cleaning, were separated into two grades, according to their thickness, and dried thoroughly in the sun. The two grades of roots were powdered and kept separately. From the analysis conducted by the Chief Research Officer, S.S. & F.M.S. to whom samples were sent, it is seen that the 'Ether extract' and 'Retonens content' of both the powders are up to the average. Table showing the result of analysis is given. Small scale sprayings with the powder for *aphis* on Brinjal gave encouraging results. The crop has been arranged to be cultivated on an extended scale.

31. The pea leaf miner, *Phytomyza atricornis* meig. in India.

TASKHIR AHMAD *and* R. L. GUPTA, New Delhi.

Hitherto known in India under the name of cruciferous leaf-miner this species has been now definitely identified as *Phytomyza atricornis*

Meig. It is a common and widespread leaf miner throughout Europe, United States of America, Australia and several other countries. The larvæ of this fly are eminently polyphagous, over 6 dozen host plants being already known. Twenty-nine species of plants have been found subject to the attacks of the leaf miner in India, of which 18 are new records. The damage to the leaves is partly due to the numerous punctures made by the female for feeding purposes, but chiefly on account of the mining of larvæ into the leaves. During March and April when the temperature is 23°–28°C, one generation is completed in about 18 days (Preoviposition period 4 days+incubation period 2 days+larval period 5 days+pupal period 7 days). The number of eggs laid per female so far known is only 51–72, but under Indian conditions as many as 329–358 eggs per female were not uncommon. A Eulophid parasite, *Solenotus* sp. has been bred from the larval stage of the fly.

32. Some Indian ants of economic importance and some methods of their control.

K. B. Lal, New Delhi.

Ants are harmless or injurious; they are seldom beneficial. They are known to act as predators of some insect pests and as scavengers but the economic value of the former habit is very doubtful and of the latter hardly appreciable. Of the injurious species, over a dozen are known from India and these include both household and agricultural pests. In the case of the latter, damage may be done, directly, by (*a*) attack on roots, seedlings, leaves and fruits of economic plants, (*b*) carrying away sown seeds from fields necessitating repeated sowings, (*c*) making nests in lawns, flower beds, etc., and spoiling their utility and appearance; indirectly, by fostering and protecting various insect pests and at times even transporting them from place to place. In the house, ants congregate and feed on various eatables—bread, biscuits, sweetmeats, etc.—sometimes making them unfit for human consumption, carry away various kinds of grains and seeds—*e.g.* wheat and coriander—to their nests and make themselves thoroughly a nuisance by appearing in large numbers in almirahs, verandahs and rooms and at times even biting inmates who came in their way.

Control naturally depends on the nature and habits of the ants. Sometimes, destruction of nests by various chemical treatments is possible and effective, at others, the nests are either inaccessible or far too many to be dealt with economically. The role of various insecticides and poison baits in the destruction of ant colonies and of some repellents of ants is discussed in the light of experiments carried out against certain species at New Delhi.

33. The *ak* grasshopper (*Poecilocerus pictus* F) as a pest of cultivated crops.

H. S. Pruthi *and* L. N. Nigam, New Delhi.

As the available records show the grasshopper *Poecilocerus pictus* is known to feed only on *ak* plant (*Calotropis* sp.) which is hardly of any economic importance. During the summer of 1937 this insect was observed doing considerable damage to the leaves and fruits of brinjal and tomato at New Delhi. A careful survey in the neighbouring area showed that all *ak* plants had been already entirely defoliated by this grasshopper. In the spring and summer of 1938 a variety of cultivated crops was tested as food plants of this species and it was observed that the hoppers fed readily and completed their development on the leaves of brinjal, tomato, *bhindi*, castor, *leuki*, radish, cabbage and oleandar. Brinjal and tomato were eaten even when *ak* was available and the three food plants were almost equally attacked. Leaves of cotton, *bajri* and *Dolichos lablab* were eaten but to a small extent. Thus *Poecilocerus pictus* hitherto regarded as a species of practically no economic importance is a potential pest of some cultivated crops.

The bionomics of the grasshopper, including the duration of various stages in the life history, number of moults, etc. have been studied in detail. Several insecticides have been tested for the control of the pest.

34. A bethylid natural enemy of the sugarcane white moth borer.

M. C. Cherian *and* P. Israel, Coimbatore.

The paper deals with a new species of *Goniozus* which the authors have found parasitic on the white moth borer (*Scirpophaga*). Details of the life history of the parasite are also recorded. The parasite takes about 10 to 15 days to complete its life cycle, the egg, larval and pupal periods being 34-46 hours, 3–5 days and 6–8 days, respectively. Observations on the habits of the parasite and its seasonal and regional variations and alternative hosts are also recorded. The paper concludes with a short discussion on the efficacy of the parasite for the control of the pest.

35. A caterpillar pest of grasses in S. India (*Cirphis albistigma*).

M. C. Cherian *and* K. P. Anantanarayanan, Coimbatore.

Cirphis albistigma, commonly known as the climbing cutworm of paddy is a serious pest of fodder grasses. During the past decade, the frequent occurrence of this pest in the fodder grasses grown at the Cattle Farm at Hosur, has demanded a detailed study of the pest in its various aspects. The observations made during the past two years are recorded in this paper. The pest occurs in grasses usually during October, November and December in a sporadic form. The life cycle from egg to adult is completed in the course of about 30–35 days. From observations made so far there is no indication of a serious 2nd brood in the same locality, and there appears to be no hibernating or æstivating stage to tide over unfavourable conditions; some preliminary trials on the control of the pest are also recorded.

36. A new caterpillar pest of Moringa in S. India (*Noorda moringæ* T).

M. C. Cherian *and* Mohamed Basheer, Coimbatore.

The insect *Noorda moringæ* attacks the flower buds of the tree *Moringa pterygosperma*. For a long time this was considered to be the same species as the leaf caterpillar—*Noorda blitealis*. As a result of recent studies the two appear to be distinct species.

The paper contains some information on the bionomics and incidence of the pest. The moth takes about 19 to 28 days to complete its life cycle. The caterpillars feed inside the flower buds which drop down as a result of the attack. The percentage of infestation in dropped buds is very high, being more than 90% in certain months. The caterpillars are not found in buds below 4 mm. in size. Eight parasites have been noted on the pest, two of which are found to be new to science. The use of Bordeaux mixture as a repellent has given fairly satisfactory results. The caterpillars pupate in the soil round about the trees and hence the soil can be raked up to kill the pupæ.

37. The control of the rice grasshopper (*Hieroglyphus banian*, Fabr.) in South India.

Y. RAMACHANDRA RAO *and* M. C. CHERIAN, Coimbatore.

Reports of damage by the rice grasshopper, as recorded in the Indian Museum Notes, go back to 1886 in Central Provinces and to 1890 in South India in the Ganjam District. Three different species of *Hieroglyphus* have often been confused: (1) *H. banian* Fabr.—the species that is commonly responsible for damage to paddy and cane, is distributed almost all over India. (2) *H. oryzivorus*, Carl.—a brachypterous form found in the northern districts of Madras, and also in Central Provinces, Bengal, Sind and parts of Baluchistan. (3) *H. nigrorepletus* Bol.—another short-winged form, usually attacking dry crops in the upland areas of North Madras; and also distributed in most parts of Northern India. Notes are given on the studies made during recent years on the rice grasshopper especially in the Ganjam and Malabar Districts. Different methods of control are also discussed in the paper, such as poisonbaits, nets, bund scraping, ploughing, etc. and suggestions are made to suit different conditions and localities.

38. Further studies on the cholam earhead bug (*Calocoris angustatus*) in S. India.

M. C. CHERIAN, M. S. KYLASAM, *and* P. S. KRISHNAMURTHI, Coimbatore.

Damage by the earhead bug (*Calocoris angustatus*) is restricted to *Andropogon* (cholam) when it comes into earheads and is usually severe in the dry tracts of the Presidency. The paper deals mainly with the incidence of the pest from the seasonal and varietal points of view. In Coimbatore, the *Chitrai* (irrigated) cholam with the compact earheads is generally affected rather severely; the *Periamanjal* (rainfed) with the loose type of earheads is less severely affected. In Guntur, the *Punasa* (rainfed—June to October) crop of cholam always shows a high infestation. Results of the experimental trials by way of control are broadly indicated.

39. Some hairy caterpillar pests of S. India.

T. V. RAMAKRISHNA AYYAR, Coimbatore.

It is well known that among insect pests of cultivated crops all over the world, the larvæ of some moths popularly known as hairy caterpillars occupy a high rank. Such forms as the Gipsy moth, the Web worms, the tent caterpillar, the brown tail moth etc. are some of the notorious forms found in Europe and America. In S. India we have about two dozen forms so far noted which could be brought under the category of hairy caterpillars. An attempt is made in this paper to give an account of the general features, and bionomics of these creatures with special reference to the different methods of their control employed against them in S. India. The more important of the species noted are *Amsacta albistriga, Paricallia ricini, Euproctis spp., Estigmene lactinea, Eupterote mollifera, Utetheisa pulchella, Diacrisia obliqua, Asura conferta, Orygyia postica, Psalis securis, Nisaga spp., and Hypsa ficus.*

40. Light reactions of *Trogoderma khapra* adults.

M. AFZAL HUSAIN *and* G. S. SOHI, Lyallpur.

Immediately after emergence 61·1% of the total females gave negative reaction. During the entire pre-oviposition period 71·4% of the adults were negative and 28·6% indifferent. During oviposition period the females showed maximum negative response and as many as 80% gave negative reaction. Further the intensity of their negative response appeared to be associated with the activity of oviposition since maximum negative reactions were obtained during the first two days of oviposition period when the females laid maximum number of eggs. Later on the negative response of the females gradually decreased and in the post-oviposition period 57% of the total reactions were negative and rest indifferent.

Males, however, retained their negative response almost throughout their life cycle except during the last day of their existence when some of them became indifferent and a few gave positive response.

41. Experiments on the summer control of plant mites.

A. N. SAPRA, Lyallpur.

The active forms of the mites *Paratetranychus indicus Hirst.* can stand immersion in water at 32°C. for three hours, but if the immersion is prolonged they die in another three hours. When immersed in water containing lime, wheat flour or pyrethrum they die within four hours. When sprayed with water at 100lb. pressure all stages excepting the eggs and quiescent stages are killed, but when sprayed with water containing lime, wheat flour or pyrethrum the quiescent stages are killed as well.

Lime sulphur spraying with at least 0·18% sulphur content gives 100% mortality of the mites, but it has no effect on the eggs. However, the larvæ that emerge within 12 hours after spraying die. Moreover if lime sulphur contains spreaders like Aresket, Aresklene, Areskap, Gardinol A, Santromerse and Igepon, which are sodium salts of sulphated organic compounds, it forms a thin film round the eggs, which fail to hatch. With 1 part of these chemicals in 2,600 parts of these solutions, 90-100% mortality of the eggs is obtained. By themselves in water, they give 100% mortality of the mites at 1 : 100 ratio but at 1 : 1600 none of them has any more action than water.

Statistical methods

42. Sampling in sugarcane experimental work.

M. SUBBAIYA, Bangalore.

To determine the average degree of maturity of a plot of sugarcane, various methods of sampling are followed in India. The assumption made in all these cases is that the degree of accuracy obtained would be the same whatever may be the stage of maturity of the crop. That this assumption is incorrect is shown experimentally. The layout of the experiment was 5×5 Latin Square. When the crop was twelve months old, analysis was started by taking samples consisting of nine canes from each plot; and the analysis was continued for four months. The figures obtained for the sucrose content of the juice have been statistically examined and the size of the sample required to give a significance of 0·5 per cent. or less of sucrose was computed in each case. The following Table shows the stage of maturity of the crop as shown by the reducing-sugar ratio and the size of a sample that would give a significance of 0·5 per cent. of sucrose or less.

Serial No.	Date of analysis.	Standard deviation.	Reducing sugar per cent.	Sucrose per cent.	Reducing sugar ratio.	Size of the sample that would give an accuracy to 0·5%.
1.	30-5-1937	0·5726	1·089	15·634	6·95	135 canes.
2.	30-6-1937	0·3199	0·847	17·024	4·974	81 ,,
3.	26-7-1937	0·1645	0·405	18·810	2·153	45 ,,
4.	27-8-1937	0·1479	0·250	19·936	1·304	45 ,,

It is seen from the above table that the degree of accuracy obtained by a 45 cane sample taken when the crop is 15 months would not be reached by that size if taken at the twelfth month, but a size of sample consisting of 135 canes would give the same degree of accuracy as a 45 cane sample. Thus the size of sample should be adjusted to the different levels of maturity of the crop to get the same degree of accuracy in the results.

43. Variability of plant density and the estimation of yield of cotton by sampling.

R. J. Kalamkar *and* Dhannalal, Nagpur.

Variability of plant density, on an experimental field, is investigated for five varieties of cotton, viz., Verum 434, Roseum, E.B. 31, Verum 262 and Late Verum, grown at the Agricultural College Farm, Nagpur. The experiment consisted of five varieties of cotton replicated 4 times in randomised blocks on plots of 89′×18′. Two of these blocks were taken up for the study of sampling technique. Eight sampling units, 2 from each of the four sub-plots into which the plot was divided, were taken, a sampling unit being a 5 ft. length. The percentage variability of plant density per sampling unit of 5 feet length was observed to be 40·4 while sampling error was 59·10%.

The number of plants surviving is significantly different for different varieties which may be attributed to differential mortality of varieties under field condition and to the number of seeds per gramme for different varieties under investigation. The fact that the number of seeds per unit weight differs from variety to variety indicates the necessity of taking this factor into consideration in studying the yield behaviour of different varieties.

Significant correlation has been observed between yield and plant number. When adjusted for plant number, different varieties did not show significant differences in yields except that E.B. 31 cotton was definitely inferior in yield. Under field conditions verum 434 and verum 262 gave significantly higher yields compared to other varieties.

Comparison of estimated and actual yields indicate the possibility of using sampling technique in estimating the yield of cotton with accuracy. The standard error per sampling unit was 40·2% while the sampling error was 46·35%.

44. An estimate of error from unreplicated experiments.

G. K. Sant, Indore.

It is shown that in complex agricultural experiments, in the absence of replications, it is possible to make a valid estimate of error from the contributions due to (i) the unimportant higher order interactions, (ii) the dummy comparisons, and (iii) the deviations from the response curves. The precision attained by such an estimate of error is compared with that obtained from the replicated experiments. The utility of such an estimate is discussed with reference to the experiments carried out at Indore.

45. A 10 × 10 quasi-factorial experiment at Chinsurah with 100 strains of rice.

K. R. Nair, S. C. Chakravarti, *and* P. C. Mahalanobis, Calcutta.

F. Yates has introduced a new type of design in Agricultural experimentation which is of great value when a large number of varieties have to be tried out in the field. The design, which is known as 'quasi-factorial', avoids the need of having excessively large blocks thereby increasing the efficiency of the experiment.

Two experiments were laid out at Chinsurah during the 1937 season, one with 49 strains in a 7 × 7 quasi-factorial design and another with 100 strains in a 10 × 10 quasi-factorial design. This paper deals with the analysis of variance and co-variance of grain and straw yields of the second experiment. Significant differences among strains were noticed in respect of both grain and straw yields. The strains have been arranged according to yield of grain and straw yields. The strains have been arranged according to yield of grain after equalizing for straw.

46. On a general method of constructing the appropriate compounds in terms of the twelve 3 × 3 Latin Squares for any of the eight components $N_1K_1P_1$, $N_1K_1P_2$, $N_1K_2P_1$, etc., of the second order interaction in a 3 × 3 × 3 factorial arrangement.

K. Kishen, Calcutta.

A general method of constructing appropriate combinations with suitable positive and negative signs of the yields given by a 3 × 3 × 3 factorial arrangement for the twelve possible 3 × 3 Latin Squares so as to obtain any of the eight components $N_1K_1P_1$, $N_1K_1P_2$, $N_1K_2P_1$, $N_1K_2P_2$, $N_2K_1P_1$, $N_2K_1P_2$, $N_2K_2P_1$, $N_2K_2P_2$ of the second order interaction is given. It is seen that each of these components is expressible as a combination of the contrasts between some of the twelve Latin squares.

47. Split-plot technique in field experimentation.

K. Kishen, Calcutta.

This paper discusses a number of split-plot arrangements classified, for purposes of lucidity, under the two main heads: (i) Sub-plot arrangements, and (ii) Array strip arrangements. The appropriate methods of statistical analysis in the different cases have been explained in detail by working out actual numerical illustrations. Alongside are also discussed the merits and demerits of the various designs; and in the case of sub-plot arrangements, error variances of corresponding randomized block arrangement have been computed to study the effect, on the estimation of error, of adopting these layouts.

The object of this paper is to place before the agricultural worker in a simple and readily comprehensible manner some of the more common types of split-plot designs so that after acquainting himself with the various possible cases, he may feel well-equipped to adopt layouts best suited to his purpose.

48. Some balanced confounded arrangements for the 5^n type of experiment.

K. R. Nair, Calcutta.

In a previous paper presented to the First Session of the Indian Statistical Conference, January 1938, I discussed a method of getting confounded arrangements for the general symmetrical type of experiment, that is to say, of n factors at p levels each. The method consisted in using two systems of interchanges obtainable from a p-sided hyper-Græco-Latin Square. The method was fruitful in getting balanced sets of replications, partially confounding all the degrees of freedom of the high order interactions affected, provided $p-1$ also was a prime or a power of a prime. This method was demonstrated there in getting balanced confounded arrangements for the 3^n and 4^n types of experiment.

In the present paper similar arrangements have been obtained for the 5^n type of experiment. Thus with 3 factors at 5 levels each the 16 replications, with 5 sub-blocks of 25 plots, necessary for balancing the second order interactions have been worked out; with 4 factors at 5 levels each the 64 replicatons, with 25 sub-blocks of 25 plots, necessary for partially confounding all the degrees of freedom of the second and third order interactions, the 32 replications necessary for partially confounding all the degrees of freedom of the third order interactions alone and the 16 replications necessary for partially confounding all the degrees of freedom of the second order interactions alone have been obtained.

Agricultural Meteorology

49. On radiation minimum temperatures.

L. A. Ramdas *and* K. M. Gadre, Poona.

For practical purposes in agriculture we are concerned with the actual cooling experienced by crops and the air layers surrounding them during winter. The depressions of the minimum temperatures outside in the 'open' at different levels and above different types of surfaces below the minimum temperature recorded inside a standard Stevenson screen have been measured at the Central Agricultural Meteorological Observatory at Poona, since November 1937. The mean values of the lowering of the outside temperatures below that inside the screen are discussed. The largest differences are observed in the case of wet objects near the ground when fully exposed to the sky. A blanket thermally insulated from the soil comes next in order and the air above a grass plot comes next. The cooling undergone by the air layers decreases with height above ground.

50. Dates of onset of the south-west monsoon on the west coast of India.

L. A. Ramdas, V. Satakopan, *and* S. Gopal Rao, Poona.

The date and mode of onset of the monsoon are of great importance to agriculture in India. A study of the variability of these features from year to year is attempted in this paper. Four areas along the west coast, viz.: (1) Trivandrum Cochin area, (2) South Kanara District, (3) Ratnagiri District, and (4) Kolaba District have been chosen for this study. The average daily rainfall over these areas for the 61 days of May and June for each year from 1891 to 1936 has been computed. These data are then charted in the form of histograms. Examining these figures and adopting a suitable criterion for each area the date of onset of the monsoon for each year is determined. The series are examined for variability in time and space.

It is found that the dates are ascertainable more precisely as we go from south to the north. In the southern areas the monsoon is preceded almost invariably by a series of thunder-showers. Still, the dates can be fixed to a fair degree of accuracy by adopting a suitable criterion regarding the continuity of rain. The onset is more precise and abrupt in the northern regions like Ratnagiri and Bombay.

A search for the factors which may influence the dates of onset is being made.

The rainfall distribution of the whole monsoon season, May to October, for the South Kanara District has been examined in greater detail.

51. Studies on evaporation from the surfaces of soil layers resting on a water table.

L. A. Ramdas *and* A. K. Mallik, Poona.

A special soil evaporimeter has been devised in which a cylinder 5″ in diameter containing soil is kept with its perforated bottom in contact with water in a close-fitting reservoir. The amount of water evaporated from the surface of the soil is measured by weighing the evaporimeter daily before and after adding water to the reservoir to bring the water level up to a standard mark on a side tube. A series of these evaporimeters with soil columns of various thicknesses has been set up at the observatory and the results obtained so far are discussed.

52. A study of transpiration in relation to meteorological factors.

A. K. Mallik, Poona.

The paper describes the results of some transpiration measurements with the linseed plant in relation to contemporary meteorological factors. The leaf area, number of stomata, saturation deficit and wind velocity have been recorded. A comparison of transpiration and evaporation under similar conditions has also been made.

53. The invisible condensation of water vapour on the soil and on plant materials like stalk, leaves and grain.

A. K. Mallik, Poona.

The paper is in continuation of the earlier work of Ramdas and Katti on the exchange of moisture between the surface layers of the soil and the air layers near the ground. The exchange of moisture between plant materials like stalk, leaves and grain and the air layers surrounding them has been studied. It is seen that there is a large diurnal variation in the weights of dry specimens of plant leaves, stalk and grain. The percentage variation on dry basis is of the order of 12% in the case of soils, 5% in the case of grains, and 17% or more in the case of leaves. Further work is in progress.

54. The use of the hot-wire anemometer in studies of micro-climates.

P. K. Raman, Poona.

Daily observations were made of the wind velocity at the levels 3″, 6″, 1′, 2′, 3′, 4′, 6′ and 8′ at the same times as the psychrometric observations, namely the maximum and minimum temperature epochs, in different environments. The wind velocity was measured with the Albrecht Hot-wire anemometer. The observations were recorded during last winter both in the open and in various crops.

The observations indicate that at the minimum temperature epoch when the air layers are more or less stratified the air flow is feeble and laminar. The velocities at the minimum temperature epoch are very feeble and generally between 0·1 and 0·5 metre/second. At the maximum temperature epoch there is a general increase in wind velocity. The differences in the wind break effect of the different crops are seen more clearly in the afternoon.

The inter-correlations between winds and temperatures in different environments have been worked out.

Miscellaneous

55. Ancient farming lore with special reference to South India.

T. V. RAJAGOPALACHARYA, Coimbatore.

This paper is an attempt to present to modern agriculturists and scientific experts some of the observations and experiences of our ancestors with regard to agricultural practices in ancient days as recorded in trite expressions and sayings in songs and folk lore and in historic, religious and philosophic works during the past few centuries—especially in S. India. These ancient sayings selected from different writings of old are arranged in the paper in their proper sequence and according to the different aspects and operations of the science of agriculture such as history and antiquity of farming, status of agriculture among human avocations, selection of land, weather conditions, cultural operations, manures, seed sowing, irrigation, weeding, and interculture, wet and dry farming, cattle rearing, etc., etc. There is an abundance of agricultural lore in S. India treasured up in the numerous widely current sayings relating to the rural life of the people of the different tracts in different languages, and an examination of these goes to show that while we have very often to sift the grain from the chaff, there are germs of extremely valuable agricultural hints and suggestions which the modern experts in the agricultural sciences will do well to examine and note for guidance in their work. After all, experience is the best teacher, especially in agricultural matters.

56. Darshan-Alam set of hoes and cultivators.

DARSHAN SINGH *and* NEK ALAM, Punjab.

It is an admitted fact that at present there is no suitable implement in the market which can be termed as a successful hoe and cultivator for the Punjab conditions. Those available in the market are unsuitable for the simple reason that they are expensive, heavy in draught and complicated in their construction or use.

The authors have evolved a set of three hoes and each of these is individually a combination of a hoe and a cultivator. These hoes and cultivators, which are 2 tined, three tined and 5 tined, have been so designed that they suit the requirements of the Punjab with respect to price, simplicity of construction and utility. The 5 tined cultivator is adjustable and its width can be increased or decreased according to needs by means of telescope method, thus rendering this implement very convenient and useful for the interculture of the crops sown in lines. These hoes and cultivators can be made at a cost of Rs.3, 5-4, and 10 according to the number of tines required.

SECTION OF PHYSIOLOGY

President:—N. M. BASU, M.A.

General Physiology

1. Brain potential rhythm and levels of sleep.

B. K. BAGCHI, Calcutta.

Electrical potentials were led off from the scalp of 10 intact human subjects by means of a special radio-valve amplifier and oscillograph assembly at different stages of the psycho-physiological continuum stretching between awareness and deep sleep. A semi-sound proof, shielded room for the subject and a two-way communicative system (microphone-loud speaker) between the subject's room and the recording chamber were used. One or the other of two intensities of a pure tone was occasionally fed into the loud speaker, and the subject was instructed that if he heard the tone he was to respond to it with finger movement and report orally into the microphone his subjective condition under four pre-determined categories. Results show that there is a general correspondence between level of awareness and unawareness on the one hand and the type of brain potential on the other. But this correspondence is neither invariable nor continuous. At least four types of potentials occurring during the continuum and six levels of sleep were encountered. These levels could be spotted out by the type of potentials and the reactions or lack of reactions of the potentials to stimulus conditions. At the beginning there were alternations between different levels of sleep before one level is firmly established. Individual differences were noted.

2. Electrical stimulation of cerebral cortex followed by spreading and rhythmic grouping of brain potentials.

N. N. DAS *and* N. N. DE, Calcutta.

In rabbits and cats under urethane chloralose anasthesia, an electrical stimulation of the cerebral cortex gives rise to characteristic potential changes at its surface. The response induced by weak stimuli is a potential change lasting about 0·01 sec., in which the stimulated region becomes negative to points a few millimetre away, though these are positive to points beyond. This response due to neurones which are in the superficial layers of cortex are all directly excited by the stimulus. Stimulation with stronger currents brings about a change in the form of these responses. The stimulated region becomes positive to distant points and the responses become larger. The movements of potential wave over the cortex is due to conduction of activity from neurone to neurone (just like spreading of wave in water) in the deeper layers. A summation of excitations is necessary before one neurone can transmit to its neighbours, hence the gradual increase in the distance travelled by successive waves. These changes in the brain potentials are recorded with an oscillograph devised in this laboratory. (Chopra and Das [1935].) In the region through which the waves are conducted, no other potential changes occur but in regions just beyond, there is interference, with the normal spontaneous activity. The spreading of the waves depend upon the period of stimulation and may be followed by an after-discharge. Initially, after-discharge waves start from the same point and follow the same course as those set up during stimulation; later they become grouped, the successive waves in the group starting from different points so that a complex pattern of activity results.

3. Effects of (i) repetition of a single stimulus, applied directly or indirectly at an interval of 2 minutes, (ii) repetition of two successive stimuli under nearly the same conditions, and (iii) rapidly successive stimuli to frog's nerve-muscle preparation immersed in a solution of adrenalin or acetyl-choline in (*a*) Ca-free Ringer, or (*b*) K-free Ringer, or (*c*) Ringer, or (*d*) modified Ringer with varying concentrations of Ca or K.

G. C. MUKHERJEE, Calcutta.

These experiments were devised with a view to determining (1) the capacity of Acetyl-choline and Adrenalin to maintain muscle contractions under varying conditions of stimulation, and (2) how far these two drugs are dependent upon the two ions, Ca & K, in the maintenance of muscle contractions under the above conditions of stimulation.

A single stimulus or two successive stimuli were applied with arrangements provided by well-known Palmer's drums, and the rapidly successive stimuli were applied from a Neon-lamp stimulation unit. The nerve-muscle preparation was kept immersed in the various solutions in a modified Keith-Lucas muscle trough. The concentrations of Adrenalin and Acetyl-choline used were 10^{-3} % and 10^{-4} % respectively.

The results obtained are given below:—

(1) If a single stimulus be applied to a muscle, kept in Ringer, repeatedly with an intervening interval of 2 minutes between any two applications, contractions are found to be more or less of the same nature. If the muscle be kept in a solution of Adrenalin, the successive contractions under the above conditions of stimulation take on the character noticed during the incidence of fatigue. If the muscle be kept in a solution of Acetyl-choline, the successive contractions are found to be more and more powerful.

(2) If instead of a single stimulus a series of 2 successive stimuli be applied with an interval of 2 to 4 minutes between each two consecutive series, the 2nd contraction in each series is generally more powerful than the first, but the curves of the different series are more or less of the same nature. If the nerve-muscle preparation be immersed in Adrenalin solution, the 2nd contraction in each series is found to be either equal or less powerful than the 1st and the nature of the contractions in the succeeding series gradually takes on the character noticed during fatigue. If the preparation be immersed in a solution of Acetyl-choline, the nature of the contractions does not change, the normal difference between the 1st and the 2nd contraction in each series is generally maintained, and the contractions of the following series are found to be more powerful.

(3) When rapidly repetive stimuli are applied and the contractions are recorded on a slowly moving drum, the curve in Ca-free Ringer as against Ringer shows weaker contractions, and a delayed onset of contraction-remainder and of fatigue. The addition of $CaCl_2$ in gradually increasing doses augments the contractions, quickens the onset of fatigue and of the contraction-remainder in lower doses, but delays slightly the onset of fatigue and of the contraction-remainder at higher doses. If Adrenalin be added to these solutions, fatigue is delayed and muscle contractions are augmented, but these effects of Adrenalin appear to

be more pronounced with increasing concentrations of $CaCl_2$. Adrenalin further causes an earlier appearance of the contraction-remainder.

If Acetyl-choline be added to those solutions, it is found that in Ca-free Ringer fatigue is markedly delayed and the contractions are augmented, but with the addition of increasing amounts of $CaCl_2$, the effects of Acetyl-choline cease to be prominent.

Again, the addition of Acetyl-choline along with KCl in gradually increasing amounts to K-free Ringer brings out more and more prominently the action of Acetyl-choline in delaying the fatigue and in strengthening the contractions.

4. Range of systolic blood pressure in healthy young students.

S. N. MATHUR, Lucknow.

Systolic blood pressures of a number of medical undergraduates have been recorded by taking daily readings over a number of months. The averages of over one thousand readings of their lowest and highest figures have worked out to be 103 mm. Hg. and 158 mm. Hg.; the extremes being 96 mm. Hg. and 190 mm. Hg. These high and low figures were not found to be an individual peculiarity but was a common feature with everybody at one time or the other. It is suggested that it is not safe to pronounce a person, particularly a young one, to be suffering from a high or low pressure on the basis of a casual examination.

5. Comfort in our trains. (Kata thermometer readings between Madras and Waltair.)

D. V. S. REDDY, Vizagapatam.

Attempts are now made in many countries to ensure certain standards of comfort in trains. Some Indian Railways have already built or propose building carriages with air-conditioning arrangements.

Comfort standards for India have not yet been properly outlined. With a view to find out the comfort levels in Indian trains, dry bulb temperatures and kata-thermometer readings, between Madras and Waltair in Summer (first week of May) were recorded. Readings were taken in a second class compartment, with records of sensations of persons in the carriage.

Madras to Bezwada: Mail train affords moderate standard of comfort, as the journey is done during night. The dry Kata cooling power remained above 4. The Grand Trunk Express causes positive discomfort, as it runs over this line during day. Cooling power 2·1 to 2.

Bezwada to Rajahmundry: Readings were taken in mail train only. The standard of comfort falls, as one approaches Rajahmundry, cooling power decreasing from 5 to 1·5.

Rajahmundry to Waltair: Readings were taken on the mail train only. The train from Waltair leaves at 2-50 P.M. and reaches Rajahmundry at about 6 P.M. while the train leaving Rajahmundry a little after 9 reaches the M.S.M. terminus at 1-15 P.M. During these hours, temperature is usually above 34° Centigrade and generally maintains for hours a level of 36–38°C. or more. The dry kata cooling power is generally less than 1 and sometimes negative cooling power is noted.

Madras to Bangalore by Mail: The train timings are so arranged as to give the highest comfort possible in our trains, the cooling power ranging from 7·8 to 12.

Conclusions: Air-conditioning not economically possible on all lines and all classes. Time-tables of passenger trains between Madras and Waltair or of local trains between intervening stations, may be arranged bearing in mind the hours of the journey, and the standard of comfort available on the trains during those hours, particularly in Summer months.

6. A method for recording the rate and depth of respiration in rabbits. (Demonstration.)

S. A. Rahman, Hyderabad (Deccan).

The apparatus consists of a funnel-shaped mouth-piece *m* to which a rubber tube *r* is attached. The free end of *r* is turned inward into the funnel thus forming an air cushion between the sides of the funnel and the rubber tube. This enables the funnel to be applied in an air-tight manner over the mouth of the rabbit. The funnel is fixed to the rabbit's mouth by means of tapes attached to a leather band applied as a collar round the rabbit's neck. The respiration is recorded by a modified form of Wright's Respiration Recorder. This works as follows:—

During expiration the valve V_2, floating on mercury, is closed and the valve V_1 is pushed open and the air escapes as indicated by the arrows. At the same time a contact is made at *P*. This closes a circuit which is connected with an electromagnet *e*. As a result, the tambour valve V_3 opens and outside air enters the spirometer *S* through the inlet *i* and the writing point rises.

During inspiration the valve V_1 closes breaking the contact at *P*. This closes the tambour valve V_3. At the same time the valve V_2 opens and the air from the spirometer *S* is breathed in. The writing point descends. A slight tension is maintained at the spirometer by means of a spring *SP* in such a way that the movements of the spirometer are facilitated.

The inlet *i* may be connected to a reservoir of air of any desired composition. The sample of air actually breathed may be obtained through the outlet *a* and analyzed.

Biochemistry

7. The active group of papain.

C. V. Ganapathy *and* B. N. Sastri, Bangalore.

The activation of reversibly inactivated papain by H_2S, HCN, SH-compounds, etc., has led to the view that the active group of papain is SH. Working with the fresh latex of *Carica papaya*, we have found that by treatment of the aqueous extract of latex with H_2O_2 till the disappearance of the nitroprusside reaction and precipitation with alcohol, a preparation is obtained which retains its capacity to hydrolyze gelatin but not peptone. The 'gelatinase' activity is about 60 per cent. of the 'full' activity of the preparation. Its optimum *p*H is 3·0; Maleic acid which inhibits the activity of all enzymes with a functional SH-group has no influence on the 'gelatinase' activity of the preparation. Iodoacetic acid irreversibly inactivates the gelatinase.

These results show that the group essential for the gelatinase activity is not SH but one which irreversibly reacts with iodoacetic acid. On the other hand the peptonase activity is dependent on the presence of the SH-group.

8. Natural activator of papainases.

C. V. Ganapathy *and* B. N. Sastri, Bangalore.

A dipeptide containing cystine and glutamic acid was identified by Grassman (1935) as the natural activator for papain. Working with the fresh latex of *Carica papaya*, we have found that glutathione is a normal constituent of the latex, its presence being revealed by the capacity possessed by the latex to serve as a source of co-glyoxalase. The activation of glyoxalase has been employed as a method for the quantitative estimation of glutathione in the latex and it is found that it forms about a tenth of the total SH-compounds present in the latex (Total SH-compounds calculated as glutathione = 2 per cent. on the fresh weight of the latex). Free cysteine is absent in the latex. Glutathione along with other SH-compounds present in the latex serves as the natural activator of papain.

The tripeptide has been isolated from the fresh latex as the characteristic cuprous salt.

The fresh juices of pineapple and cucumber also contain glutathione. It would thus appear that glutathione is the natural activator of papainases.

9. The influence of ascorbic acid on the oxidases acting on adrenalin.

N. K. Iyengar *and* B. Mukerji, Calcutta.

The oxidases primarily concerned in the oxidation of adrenalin are: (1) The Phenolase (Indophenol oxidase), and (2) the Amine oxidase. The influence of ascorbic acid on the two systems, adrenalin-phenol oxidase and adrenalin-amine oxidase has been investigated. The phenol oxidase used for the experiments was obtained from *Dolichos lablab* and the amine oxidase was prepared from rabbits' liver. The oxidizing action of the phenol-oxidase was studied both colorimetrically and biologically (blood pressure response in pithed cat), while the amine oxidase action was measured by estimating the liberated ammonia as a result of oxidation. Ascorbic acid was found to inhibit the phenol oxidase action, the duration of inhibition depending on the concentration of ascorbic acid. The activity of the amine oxidase was not impaired by ascorbic acid and the oxidation of adrenalin proceeded at the normal rate. These results afford an explanation for the destruction of adrenaline in the tissues even in presence of ascorbic acid. Further work on the mechanism of destruction of adrenalin by amine oxidase and the effects of various stabilizers of adrenalin, on this system, are in progress.

10. A preliminary note on the relationship between the copper content and the ascorbic-acid-oxidase activity of the different protein fractions separated from the drumstick juice.*

N. M. Basu *and* G. K. Ray, Calcutta.

M. Srinivasan made a preparation of ascorbic-acid-oxidase from drumstick juice by the precipitation of proteins with $(NH_4)_2SO_4$. The authors wanted to ascertain (1) with which protein fraction this hexoxidase remains principally adsorbed, and (2) if there is any relationship between the copper content of this fraction and its hexoxidase activity.

The expressed drumstick juice was saturated with $(NH_4)_2SO_4$ crystals for the precipitation of all the proteins. The precipitate was then filtered off under suction, washed several times with a saturated solution of $(NH_4)_2SO_4$ prepared with copper-free distilled water and rapidly sucked dry. This precipitate was then treated successively with 50 c.c. each of copper-free distilled water, 5% NaCl solution, 0·4% NaOH, and 75% alcohol. The treatment consisted in shaking the substance in a rocking machine for 15 mins. with each solvent, filtering, washing with the solvent (the precipitate being sucked dry after washing) and then making the filtrate up to a definite volume. As the oxidase has been found by Srinivasan to be destroyed completely by alcohol, the precipitate was treated with alcohol last of all.

The filtrate obtained after each treatment was tested quantitatively in a small but definite portion for its hexoxidase activity. After the

3rd treatment a fraction of the precipitate was suspended in water and its hexoxidase activity was examined in order to find out if any oxidase was still left, for the next treatment with alcohol is likely to destroy the activity of the oxidase that might still be left behind in the precipitate.

The remaining portion of each of these filtrates was then evaporated to a small bulk over a water-bath and then treated with H_2SO_4 and perchloric acid over the bath of boiling water till the combustion was complete. The liquid was then slowly evaporated to dryness over the bath. The residue obtained from each filtrate was then weighed and the copper content was then determined by a micro-chemical method.

The results of these experiments are given below:—

	Ascorbic-acid-oxidase activity.	Copper content.
1st filtrate	appreciable	1·0 mgm.
2nd ,, ...	very slight	0·008 mgm.
3rd ,, ...	practically nil	very slight trace.
4th ,, ...	nil	0·1 mgm.
A fraction of the precipitate after the 3rd treatment. ..	practically nil	not determined.

The results could not be confirmed as drumstick was not available either during rains or afterwards. The work will be again taken up for confirmation during next summer when drumstick would be available.

11. Note on the duration of the activity of salivary enzymes on cloth.

S. N. Mathur, Lucknow.

Experiments have been done to determine the persistance of activity of salivary enzymes in spit on cloth. It has been noted that the activity persists for about 10 months if kept in shade and for about 4 months if kept exposed to sun and weather.

12. Estimation of conjugated glucuronic acid as a test for liver function.

B. Mukerji *and* R. Ghosh, Calcutta.

The amount of conjugated glycuronic acid in 24 hours collection of urine of healthy rabbits kept on a standard diet in metabolism cages was measured by Salt's modification of Tollen's naphthoresorcinol test. The final colour comparison was made by means of Pulfrich photometer and the amount of glucuronic acid excreted was expressed in terms of the extinction coefficient. The average daily excretion was found to vary between 1 and 3. Chloral Hydrate, a glucuronogenic drug, was then administered by the stomach tube in doses of 250 to 450 mg. per kilo. body weight of rabbit and the excretion level was found to be between 5 to 10 approximately. The livers of these rabbits were then damaged by the oral administration of carbon tetrachloride (0·5 c.c. to 2·0 c.c. per kilo.) for several days. With the same dose of chloral hydrate administered after liver injury, the glucuronic acid excretion was increased to 15–39. An attempt is being made to develop a liver function test based on this significant and graded rise in the glucuronic acid excretion level.

13. Nonprotein nitrogenous constituents of blood.

S. K. Gokhale, Bombay.

Standards for the normal averages for the non-protein nitrogenous constituents in blood have been worked out by the study of the bloods of 126 healthy young men from the Bombay Presidency between the ages of

18 and 32 years. The averages were obtained by the analysis of unlaked blood filtrates according to the improved technique of Folin (Folin: 1934, Lab. Manual of Biological Chemistry, Vth edition). The prevention of laking of the red corpuscels gives a filtrate free from material set free by the disintegration of the red cells. The total non-protein nitrogen is completely accounted for by the sum of the amounts of the different non-protein nitrogenous constituents, which was not the case when laked blood filtrates were used for analysis. The following average figures in mg. per 100 c.c. were obtained. Total non-protein nitrogen : 18·43; Urea nitrogen: 12·56; Uric acid: 3·02; Creatinine: 1·17; Total creatinine: 1·45; and Amino acid nitrogen: 3·88. Comparative results are also given for analysis of laked and unlaked filtrates from the same bloods. The total non-protein nitrogen, creatinine, total creatinine and amino acid nitrogen content values in unlaked filtrates are markedly lower than those obtained in laked filtrates. The uric acid and urea nitrogen values in unlaked filtrates are only slightly lower.

14. Lead in human hair.*

K. N. Bagchi, H. D. Ganguly, *and* J. N. Sirdar, Calcutta.

It has been found by American and European workers that lead is present in normal human tissues in determinable quantities. The authors have also arrived at the same conclusion by examining tissues of all classes of people who had never been to town and cities and never exposed themselves to lead in any way. According to Roche Lynch and others the bones especially the long bones of a European are very rich in lead (as much as 146 mgms. of Pb per kilo) and are believed to be depots where it is deposited as an insoluble phosphate which is slowly converted into soluble salts for elimination through the bowels and kidney. An Indian eliminates about 0·16 mgms. of lead per kilo of fæces and 0·014 mgms. per litre of urine. These figures are much lower than those obtained in a European (Bagchi and Ganguly, *Ind. Jour. Med. Res.*, 1937).

No information about the lead-content of hair is available in the literature on this subject. The authors have discovered that lead forms an important constituent of hair. In fact, the quantity is much larger than what is found in the other tissues including bones of an Indian. It is not known in which form it is present in hair and if it is connected in any way with the metabolism. These facts raise the following questions: (1) Does hair serve the purpose of an excretory apparatus for elimination of lead? (2) Do the blood vessels of hair follicles possess special power for filtering out lead for purposes of elimination? (3) Is lead connected in any way with the production of characteristic pigments of hair in different races? (4) Does it play any part in the metabolism of tissues or of certain tissues of the body? The investigation is in progress.

15. Estimation of inorganic phosphorous by absolute colorimetry.

D. N. Mullick, Calcutta.

The estimation of inorganic phosphorous in biological fluids, foods and other tissues is carried out by the modified method of Fiske and Subbarow (1925). The colours of the fluids are compared by Pulfrich photometric procedure in place of the colorimetric comparison method. This instrument has the following advantages as compared with the ordinary colorimetric method:—

1. Absolute colorimetry does not require a standard solution. It determines the amount of light absorption of the solution to be examined by absolute measurement of the narrowly defined field of the spectrum with the aid of the quantitatively variable light dimension.

2. We have here a direct measurement of the intensity of the transmitted light.
3. There is the possibility of elimination to a greater extent of the solvent's own colour by the use of a proper filter.
4. Moreover it is an easy, time-saving, accurate and reliable instrument.
5. Details of procedure and solutions required are given.

16. Histological chemistry of voluntary muscle.

A. Ghaffar, Nagpur.

A study of diffusion of various substances into and out of the voluntary muscle of frog when immersed in Ringer's solution to which a known amount of the substance under investigation has been added, shows that the normal concentration of various constituents of muscle water may differ considerably in that portion which allows a free diffusion of all dissolved substances between it and the saline, and that portion which seems to be enclosed by membranes which do not allow such exchange of certain substances. A method of calculation is given for the determination of normal concentration of various substances in the muscle water of those two portions. A table is appended giving the gross concentrations of these substances in muscle and the calculated concentrations in each of the above two portions of muscle water.

17. Nutrition studies in Bihar. I. (Dietary habits of the college students at Patna.)

K. Mitra, Patna.

A dietary survey in terms of actual foodstuff consumed was carried out in twenty-four kitchens connected with the local college hostels, catering for about 500 students. The students were found to be mostly vegetarians and only about 30 per cent. did not have objections to flesh foods. The average intake per capita per diem came up to cereals 16·8, pulses 3·6, nonleafy vegetables 15·8, leafy vegetables 1·2, fats 2·4, flesh foods 1·8, milk and milk products 0·7 and fruits 0·3 ounces. The standard quantitative requirements in the above dietary were completely satisfied but barring few kitchens, the diet suffered badly from the lack of animal protein and leafy vegetables. Of the total amount of cereal grains consumed, about half consisted of raw milled rice and a third of wheat flour. Parboiled rice was not found to be popular and home-pounded or *dhenki* rice was unknown. It was gratifying to note that about 94 per cent. of these boarders (students) supplemented their routine meals with snacks from outside the kitchen. Amongst the various edibles used as supplementary food, milk was found to be the most popular item (63% students). milk-made sweets, fruits and flesh foods coming next in order of preference. An attempt was also made to find out which one of the sixteen items of supplementary edibles were consistently used by the consumers of that particular group and it was found that milk drinking topped the list (9·02 days in 10 days). Next in order of preference came ghee and butter.

18. Endogenous protein metabolism of man and the distribution of sulphur in human urine on non-protein diet and on diets containing different amount of proteins of rice and whole wheat (Atta).*

K. P. Basu, M. N. Basak, *and* M. K. Haldar, Dacca.

1. The daily minimum nitrogen excretion in urine by a human subject on a non-protein diet has been determined and found to be 0·03 gm. per

Kg. body weight. If the feacal nitrogen elimination be added to the urinary elimination, the total nitrogen output comes out to be 0·05 gm. per Kg. body weight; this is the absolutely minimum nitrogen requirement.

2. Total N, creatinine N, total S, inorganic S, and ethereal S in urine of a subject on various diets containing different amounts of rice and wheat have been determined.

3. It appears that ethereal sulphates are purely products of detoxication of phenolic substances, produced by the bacterial decomposition of dietary protein.

Similar amounts of ethereal sulphates are found to be excreted in urine on both rice and wheat diets, while it is absent on non-protein diet. This shows that rice and wheat diets are almost equally susceptible to bacterial putrefaction, while non-protein diet is not.

4. The significance of S : N ratio of urine on non-protein diet is discussed. The value of S : N (1 : 8·5) on non-protein diet indicates that on such a diet the endogenous nitrogen metabolism represents the metabolism of non-protein nitrogenous constituents of the tissues, whereas the fasting metabolism (S : N = 1 : 14) is the result of disintegration of body protein.

19. Metabolism of calcium and phosphorus in human beings.*

K. P. Basu, M. N. Basak, *and* B. Raychowdhury, Dacca.

1. Metabolism of calcium and phosphorus on two typical Indian dietaries were studied in Indians.

2. On a diet containing 600 gm. wheat there was considerable retention of phosphorus and calcium but on a diet containing the same quantity of rice, there was negative calcium balance, although accompanied by phosphorus retention. It is evident, therefore, that rice diet is deficient in supplying the calcium requirement of man and that a portion of rice in rice-eater's diet should be replaced by wheat.

3. Supplementation of typical rice diet with milk enormously increases the retention of calcium and phosphorus thus improving quality of the diet.

4. Ingestion of large excess of energy in the form of sugar over normal energy requirements has got an adverse influence on calcium and phosphorus metabolism.

5. The daily minimum maintenance requirement of calcium and phosphorus per adult of 70 kilo body-weight was found to be 0·27 gm. and 0·91 gm. respectively.

20. Sub-clinical Vitamin A deficiency studied by a photometer.

M. Narasimharao *and* G. Sankaran, Calcutta.

Visual purple, the active photosensitive principle of the retina, is known to be constituted chiefly by a protein and Vitamin A. Visual purple circulates in the retinal vessels and is disintegrated into its components proportional to the amount of light. The disintegrated products circulate in the organism and are reformed into the Visual purple, the reformation being proportional to the Vitamin A in the system.

This principle is utilized in the instrument described, designed by us for the purpose of detecting sub-clinical Vitamin A deficiency. Each test takes less than five minutes: an advantage achieved for successfully utilizing the apparatus during field work.

Six hundred convicts from a local jail on various grades of diet are examined with the photometer and the results correlated with the Vitamin contents of their diets.

The favourable effect of administration of Vitamin A on the results, has been proved on a group of volunteers.

21. The Vitamin B-complex in toxic conditions.

A. Mukherji, Amsterdam.

What factors of the yeast neutralize the toxic effects of large amounts of cod-liver oil have been determined. For this purpose more than hundred white young rats were taken and they were given different foods made up of washed rice, washed casein, salt mixture, full dried and autoclaved yeast, cod-liver oil from 8–15% and peanut oil. The different factors of the yeast were given in the form of pure synthetic preparations of aneurin (Vitamin B_1), Vitamin B_2, frankonite filtrate of aqueous yeast extract, autoclaved yeast, and also nicotinic acid. It was found that at least three factors of the Vitamin B-complex can neutralize the toxicity caused by large amounts of cod-liver oil, viz. aneurin, Vitamin B_2, and an unknown factor in the frankonite filtrate of the auqeous extract of yeast (this being heat labile). As far as the neutralization of the toxicity of large amounts of cod-liver oil is concerned possibly the Vitamin B_2 is more potent than the other factors of the Vitamin B-complex severally. The different factors of the Vitamin B-complex act better when given at the same time than any individual factor alone. Possibility of this latter finding was guessed by Coward some time back, though she could not prove it at that time. This shows that a fair trial should be given to the Vitamin B-complex instead of aneurin alone in cases where it is indicated.

22. Observations on the state of saturation of Bengalee boys with regard to Vitamin C.*

N. M. Basu *and* G. K. Ray, Calcutta.

In determining the state of saturation of these boys the authors ascertained their average urinary output of Vitamin C in 24 hours with the normal diet, and then the total amount of ascorbic acid required to be administered before their urinary excretion reached a constant figure or nearly approached the amount ingested. The second part of the investigation was carried out in two stages. In the first stage boys were given sufficient fruits so that the daily intake of 200 mgms. of ascorbic acid was ensured. In those cases in which the normal urinary output of cevitamic acid was very low, the fruits were supplemented by 200 mgms. more of ascorbic acid crystals. In the second stage, they were given only Vitamin C in the form of standardized Vitamin C tablets. If the urinary output was found to be very low, they were given 500 mgms. daily till the urinary excretion reached a constant figure.

In the 1st stage, the authors determined not only the free Vitamin C in urine, but also dehydro-ascorbic acid and combined ascorbic acid both in normal urine and in urine after the administration of fruits some of which contain only free ascorbic acid and others contain generally free ascorbic acid with a small amount of its derivatives. In the 2nd stage, they determined only the total reducing value and the free Vitamin C both in normal urine and in the urine after administration of Vitamin C tablets, for they found that after the administration of Vitamin C tablets the urinary excretion of combined Vitamin C was not affected. In the first stage the number of boys examined were 6. Of these, two do not, as a rule, take fruits, two take fruits frequently but were not taking fruits just before the experiment, and two others take fruits frequently and were also taking fruits just before the experiment. Of the 1st set, one member did not reach saturation after the intake of 3,000 mgms., the other required 2,600 mgms. to reach saturation. Of the 2nd set, one required 1,000 mgms. and the other only 350 mgms. to reach saturation. The most curious thing is that the normal urinary output of free Vitamin C in all these four cases was below 15 mgms. (viz. 7·4, 7·8, 8·4 and 13·4 mgms.), although they showed very widely different states of saturation. The output of dehydro-acid and combined acid was erratic.

In the 2nd stage, the number of boys examined were 11. Of these, only 1 was taking fruits before the experiment and he was found to be in a state of saturation. His normal urinary output was also high, viz. 66 mgms. In the case of the remaining ten persons, the normal urinary output of free Vitamin C was very low, varying between 1 mg. to 12 mgs. excepting 1 boy whose excretion was 23 mgm., but they required widely different amounts for reaching saturation, e.g. one student excreting only 1 mg. required 1,500 mgms. for reaching the lower limit of saturation, whereas another excreting 12·4 mg. did not show any increase in urinary output after the intake of 2,000 mgms. One boy again, after the intake of 3,500 mgms., did not reach the lower limit of saturation. From these results it is concluded: (1) that the normal urinary output of Vitamin C is no indication of the state of saturation of the body, (2) that the average urinary output of Vitamin C in Bengalee boys is much less than that found by Harris and Ray, (3) that persons taking fruits from time to time but excreting a small amount of Vitamin C in urine, require less amount of Vitamin C to reach the state of saturation, than those who do not, as a rule, take fruits, and (4) that the Bengalee boys are, as a rule, unsaturated, though to a different degree, with regard to Vitamin C.

23. Observations on the minimum requirements of Vitamin C of Bengalee boys.*

N. M. Basu *and* G. K. Ray, Calcutta.

In determining the state of saturation of Bengalee boys with regard to Vitamin C, it was considered necessary to ascertain the minimum requirements of this vitamin by our boys whose dietetic habits differ widely from those prevailing in Europe and America. The minimum requirement was ascertained in the following way:—

The boys were first brought to a state of saturation with this vitamin by the administration of large doses. Then the intake of this vitamin was continually reduced till that minimum dose was found at which the rate of urinary excretion was maintained at 30% of the intake for several days; for, in the opinion of various workers, 30% urinary excretion of the amount ingested represents the lower limit of the state of saturation of the body. Thus, the figure for vitamin obtained as a result of these experiments represents the minimum amount necessary to keep the body in the lower limit of the state of saturation of the body. The experimental results are given below:—

Of the six boys examined two are found to require 25 mgms. and the remaining four, 50 mgms., exclusive of the very small amount of Vitamin C present in their foods which do not, as a rule, include leafy vegetables and fruits. But of the two boys requiring 25 mgms., one was taking a pretty large amount of leafy vegetables during the course of the experiment and this fact probably accounts for his low requirement of Vitamin C.

24. Free and total ascorbic acid content of some common Bengali foods before and after cooking.

R. Neogy.

The Vitamin C content, both free and total (including dehydro- and combined-), of about twenty vegetables, commonly used in Bengal, were determined, first in the uncooked condition and then after cooking.

The free ascorbic acid was determined by the usual indophenol dye technique. The total acid was obtained by heating the extracts of foods in an atmosphere of H_2S for twenty minutes, then driving out the excess of H_2S by a strong current of CO_2 and finally titrating with the standardized dye. The difference of this titration value and the value obtained in the first case, i.e., before heating, gives the amount of dehydro and combined ascorbic acid present in the foods.

The results show varying degrees of destruction of the vitamin in different foods after cooking.

25. Applicability of Rotter's test in field investigations in the determination of vitamin C deficiency.

D. D. MITRA *and* G. SANKARAN, Calcutta.

Work was done to determine the efficacy and the practical applicability of Rotter's test in the field as a means of ascertaining deficiency, or otherwise, of vitamin C. Four members of the laboratory volunteered to be experimental subjects. The daily excretion of ascorbic acid in the urine was determined every day, and each one of us used to have daily two intradermal injections, one on either forearm, of a 0·04% solution of 2 : 6 dichlorophenol indophenol, during the whole of the experimental period of about a fortnight. After determination of the time of disappearance of the dye at the level of usual excretion of the ascorbic acid, we got ourselves gradually saturated with ascorbic acid by taking it orally for some days till saturation level was indicated in the urine, remained there for about 3 or 4 days, and then gradually came down again.

The results however indicate no correspondence between the time of the bleaching of the dye and the quantity of the ascorbic acid in the body. Hence Rotter's test does not seem to be applicable.

26. On the activity of liver concentrate.

U. P. BASU, Calcutta.

Even in spite of the recent extensive investigations (*cf.*, Dakin and West, *J. Biol. Chem.*, 1935, *109*, 489; Laland and Klem, Acta. Med. Scand; 1936, *88*, 620; Subbarrow, *et al*, *J. Amer. Chem. Soc.*, 1936, *58*, 2234, and others) on finding out the active principle present in the liver extract, any definite knowledge is still lacking regarding the factor or factors that are really responsible for the efficacy of the concentrate in the treatment of primary anæmias. It is generally believed that the active principle does not consist of single substance, but the efficacy of any particular concentrate depends upon the various entities, that must be present in it (*cf.*, Murphy, *Amer. J. Med. Sci.*, 1936, *191*, 597; Karrer, *Helv. Chim. Acta.*, 1938, *21*, 314).

On this principle a work has been undertaken to fractionate the liver extract according to the well known principle of Cohn and his coworkers (*J. Biol. Chem.*, 1928, *77*, 325). But in obtaining the extract itself the minced ox liver instead of being initially treated with alcohol-sulphuric acid mixture as directed in the British Pharmacopoeia, it is being pressed with 0·1% hydrochloric acid to afford an extract which has been subsequently fractionated according to Cohn and others (*loc. cit.*) slightly modified. In this way several fractions have been obtained and collected. These are being chemically analysed to ascertain the nature of nitrogenous substances present as far as possible. The different fractions are also being physiologically tested. The experiments are in progress, but it may be pointed out here that the fraction which is being found to possess no appreciable activity, is, however, often being noticed to enrich the potency of the fraction already active.

Pharmacology

27. Studies on some dextro-rotatory hydrocupreidine derivatives. Part III. Action on *Paramoecium caudatum.*

B. MUKERJI *and* R. N. CHOPRA, Calcutta.

The comparative activity of a group of 13 dextro-rotatory hydrocupreidine derivatives on *p. caudatum* was studied in slide-coverslip preparations. The hydrogen-ion concentration of the solutions ranged between 5·4 to 6·8, as the cupreidine salts were not easily soluble otherwise. Controls with hydrochloric acid with similar hydrogen-ion concentration were run side by side. The end point was noted when either the whole population of the free-swimming organisms was dead or more than 75% of them were dead. The figures obtained in this way indicate that the dextro-rotatory hydrocupreidine derivatives are fairly toxic to the paramoecium obtained from hay culture, the toxicity generally increasing with the lengthening of the carbon atoms in the side chain. The higher members of the series are lethal to the paramoecium in a concentration as low as 1 in 1,000,000.

28. Action of drugs on the coronary flow.

B. Narayana, Patna.

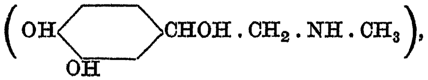
The isolated heart lung preparation of the dog was used to investigate the action of certain drugs on the coronary circulation. It was observed that Histamine and Ephedrine caused a marked increase in the coronary flow. Ergotamine and Acetylcholine caused only a slight increase; Pituitrine caused a decrease and Atropine had practically no effect.

29. Correlation between chemical constitution, pharmacological action and enzymatic breakdown of certain adrenalin-like amines.

B. Mukerji *and* N. K. Iyengar, Calcutta.

A study of the action of an oxidase obtained from *Dolichos lablab* on

Adrenalin



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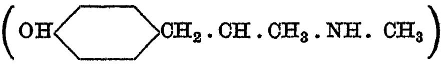
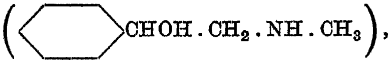
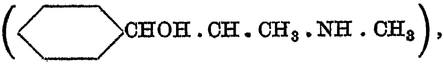


Propadrine



Ephedrine



has shown that both adrenalin and veritol are attacked by the oxidase (indophenoloxidase), the rate of destruction being more pronounced in case of the former than in the latter. Propadrine and Ephedrine are not attacked by this enzyme. Simultaneous chemical and biological assay confirms this finding. Blaschko (*Jl. Physiol., 93,* 1938) has shown that adrenalin is rapidly oxidized in presence of amineoxidase whereas veritol, propadrine and ephedrine are not similarly affected. Pharmacological study had definitely proved that adrenalin action is intense but evanescent, ephedrine action is less intense but durable and that veritol, action is intermediate between the two. The pharmacological action of these amines therefore appear to run parallel with their enzymatic hydrolysis by both indophenoloxidase and amineoxidase. As both these enzymes are present in the body tissues, these evidences seem to offer a satisfactory explanation of the evanescent action of adrenalin (attacked by both the oxidases), the comparatively more stable action of veritol (attacked by indophenol oxidase only) and the durability of action of ephedrine (not attacked by either enzyme).

30. Some observations on the action of coramine as an analeptic.

B. N. Ghosh *and* P. C. Adhya, Calcutta.

Coramine (Pyridin—β carboxylic acid diethyl amide) is generally considered to be a stimulant to the respiratory and cardiovascular systems and has been used rather extensively in clinical practice. The authors have carried out pharmacological experiments on laboratory animals and find that coramine in ordinary therapeutic doses has no action on blood-pressure and respiration but in larger doses, it might depress both. The drug may act as an analeptic as it is found to antagonize the depressor effect of morphine.

31. The effects of some ions on the action of Urea-stibamine on frog's heart.

P. Biswas, Calcutta.

N. M. Basu showed that Urea-stibamine is highly depressant to frog's heart at the dose of 4·5 mgm. % and above and that washing the heart with Ringer after depression causes a marked rebound. The same result was also obtained by me with old ampoules in stock in the laboratory but the results obtained with fresh ampoules differ markedly from the observations of Basu. At the dose of 5 mgm. % or at higher concentrations up to 25 mgm. %, the effect of Urea-stibamine on heart was found to be practically the same viz.: slight but noticeable depression during perfusion, followed by rebound for some time during washing with Ringer's Sol.:—

The influence of ions such as Ca and K on the action of Urea-stibamine was studied and the results obtained are as follows:—

(*a*) In Ringer deficient in Ca, the heart beat begins to be depressed within a short time after perfusion and the depression becomes conspicuous after about 2 to 3 mins. The addition of Urea-stibamine to the solution (i.e. O . CaR) not only causes an earlier incidence of depression but makes the depression more marked than before. The addition of increasing amounts of $Cacl_2$ to O . CaR and Urea-stibamine counteracts the inhibitory effects of Urea-stibamine, so that the inhibition becomes much less pronounced.

(*b*) In Ringer deficient in K the depression of heart-beat is not marked. The addition of Urea-stibamine does not produce an appreciable change in heart beat, but the addition of increasing amounts of KCl to O . KR and Urea-stibamine causes an inhibition of heart-beat.

It is, therefore, concluded that $CaCl_2$ inhibits the effect of Urea-stibamine whereas KCl potentiates it. Thus the effects of Ca and K on Urea-stibamine are similar to their effects on Acetyl-choline. It is likely that Urea-stibamine produces its effect on heart by liberating acetyl-choline.

Anatomy

32. The lumbo-sacral plexus and the innervation of muscles in primitive mammals.

Brij Mohan Lal, Hyderabad (Deccan).

The primitive features in these mammals as far as the nerve supply is concerned is indicated by the following:—

1. The nerve supply of most of their muscles is not rigid, as in the more highly organized mammals in whom each particular muscle is supplied by a particular nerve.

A greater number of muscles receive their nerve supply from more than one source.

2. In some of them, the lumbar and the sacral plexuses are independent of each other on account of the absence of loops between the two plexuses.

3. The nerve to *M. piriformis* is closely bound up with the pudendal nerve.

4. The hamstring muscles are supplied by the ventral division of the sciatic, which passes ventral to *M. piriformis.*

5. The femoral and the obturator nerves separate usually from one common nerve trunk.

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SECTION OF PSYCHOLOGY

President :—H. P. Maiti, M.A.

Sensation, Perception and Memory

1. Visual perception of geometrical figure in indirect vision.

M. Ganguli, Calcutta.

This paper, supplementing a previous one submitted in the year 1933, is based on a comparatively large number of data and deals with some special character of the problem.

The threshold values are shown in a more systematic form with distortions of figure and phenomenal characters where necessary.

The chief purpose is to present a comparative study with a graphic representation of the threshold values and to find out the general character of Direct and Indirect vision when a trained individual is used as the subject.

2. Towards a dynamic theory of space-perception.

N. N. Sen Gupta, Lucknow.

The paper begins with a phenomenal analysis of the various sensory spaces. It is found that these spaces are ill-defined in their contour and have to be described with the help of terms that signify movement. Such dynamic indication is more apparent in the case of olfactory, auditory and kinæsthetic experiences than in the case of visual perception, although in the latter case too, they are not entirely absent.

The paper attempts to formulate a theory of space-perception that maintains a certain parallelism with the data that the foregoing analysis reveals.

3. The importance of visual image in tactual localization.

K. C. Mukherji, Dacca.

Experiments were made in two series in one of which localization was made, so far as possible, in terms of tactual sensations, while in the other as much prominence as possible was given (*e.g.* by keeping the eyes open and fixed on the arm during the application of the pressure and then closing the eyes for localization) to the visual image. The results have been critically treated.

4. D.L. for lifted weights by the method of continuous increase of the standard.

Gopeswar Pal, Calcutta.

Standard weights were increased at a uniform rate by different amounts in different trials. Judgments regarding increase were taken at the end of each trial. Constant method was applied. Seven different standard weights were taken. Two observers took part in the investigation. Four different rates of change were selected.

Weber's Law was found not to be satisfied. Relative D.L. values decreased in some definite order with increased values of standard weights. The curve representing the relative D.L. values and the standards has been found to be a parabolic curve of the second order.

5. An experimental study of the difference between lines visually apprehended and lines drawn.

N. N. Sen Gupta, Lucknow.

The paper presents the data of a series of experiments in which visually presented lengths are reproduced when the stimuli have been withdrawn. It is found that there is always an overestimation in reproduction. The paper proceeds to analyse the data and to suggest an explanation of the phenomenon.

6. The influence of colour on the estimation of area.

S. C. Mitra *and* A. Datta, Calcutta.

The object of the present series of experiments reported here is to find out how far the colours of perceived objects influence, if at all, our estimation of size. The method chosen was as follows:—From white, black, red, green, yellow and blue card boards pieces were cut out bearing the shapes of square, circle and equilateral triangle. Five different sizes of each geometrical figure of each colour were selected for the purpose of the experiment. By method of paired comparison every one of the squares of one colour was compared with the squares of the same size of all the other colours. Similar methods were followed in the cases of circles and triangles. The tabulated results given in the body of the paper indicate that there is some slight evidence in favour of the view that colours do influence our estimation of size.

7. Colour memory—an experimental study.

P. Razdon, Benares.

Three experiments were devised for testing colour memory. Methods of testing colour memory include the remembering of colours by the help of names, associations, visual imagery, 'latent memory', 'ideal image' and synæsthesia. The following conclusions were arrived at:—

(1) The six spectral colours used in the experiments form themselves into three groups:—

Yellow	Easy (to memorize).
Red	
Orange	
Blue	Normal.
Green	Difficult.
Violet	

(2) The five grades of saturation (of the above colours) sort themselves into two groups:—

Tints (very light)	Easier (to memorize).
Tints (light)	
Pure or Saturated Hues.	More difficult.
Shades (dark)	
Shades (very dark)	

(3) Women are superior to men in immediate colour memory, but in retentive colour memory men are slightly better. The educated British male has a better colour memory than the educated Hindustani (Indian) male.

(4) Correlation between retentive memory for saturated hues and that for shades and tints is found to be 0·85 ± ·05.

(5) For the six saturated colours, the greatest forgetting takes place within the first seven days and then again between the fifteenth and thirtieth day; but for shades and tints (of yellow, green and blue) the amount of forgetting is greatest within the first fifteen days.

8. An experiment on æsthetic value.

N. S. N. Sastry, Mysore.

A set of 10 colour reproductions of paintings was formed. The set consists of a variety of paintings—some are reproductions of great Masters, some are ordinary ones and two are pictures which are to be seen on calenders and chocolate boxes. The set represents a variety of interests, *i.e.* human-beings, natural scenes and still life studies, etc.

The paired comparison method and the ranking method were used to determine the æsthetic value of these pictures. For some subjects the ranking method and for some the paired comparison method was given first, so that the effect of the order of presentation was cancelled. The coefficient of correlation for both the series was —·82. The average preference score for each picture was determined. Ranks were given to each of the pictures, on the basis of these scores. Thus a scale was built up.

This scale was used to determine the æsthetic value of the pictures in the series. Each subsequent individual performance was compared with this scale. In every case the coefficient of correlation is positive, showing that the pictures themselves possess a value of their own. This may not be the value that the individuals attach to the pictures. This is either increased or decreased by the super-imposition of the subjective value. The result gives support to the view that æsthetic value is an emergent one.

General Problems

9. Psychological study of language.

G. Bose *and* D. Ganguly, Calcutta.

The paper is a continuation of the article under the same title, read before the Section of Psychology in the last Jubilee session of the Indian Science Congress held in Calcutta. The joint authors have discussed in the present communication the psychological significance of the preposition to' in language and the distinction between 'I wish to do a thing' and 'I want to do a thing' from the psycho-analytical standpoint.

10. Fear and anger responses of adults.

Parsram, Lahore.

Eighty adults of both sexes were asked to check a list of 86 situations which usually arouse fear or anger. They were also asked to check from a list the diseases they had suffered from. On the basis of this inquiry the relationship between disease sex and fear and anger arousing situations is worked-out.

11. Psycho-analytical theory of meaning. Part I.

Kali Prosad, Lucknow.

1. Origin and growth of meaning: Like all activities meanings have *instinctual* foundations, *e.g.*, Libido (Freud); Unconscious (Jung); Superiority-Urge (Adler). These instincts function in various ways often incomprehensible and always unconscious.

2. This leads to the 'accrual' of peculiar meanings to simple behaviour-patterns, through the functioning of various mechanisms or dynamisms such as condensation, symbolization, etc.
3. Transference and 'irradiation' of meanings: From one behaviour-pattern to another through emotional 'crises'. In this transfer there is often *fixation of meaning* either for unrecognizable causes or because of training and 'induction'. Hence we have the phenomenon of *Induction of Meaning* through 'conditioning'.
4. Fixation is best illustrated in obsessional neurosis, phobia, hysteria, melancholia, etc. Some case-histories.
5. Transformation of meaning: a part of the Psycho-analytic technique.
6. Criticism and modification of the Psycho-analytical theory.

12. Psycho-ethics: ancient and modern.

B. C. GHOSH, Calcutta.

1. Study of Behaviour. Hindu theory of conduct in the *Trivargas*; the Psyche underlying the *Varga-acharana* suggested in the *Trigunas*.
2. Budhistic insight into evolution in its fivefold order—*Pancha Niyama*; reconciliation of contradiction between *Nairatta* and *Attasdupa*.
3. B. Russell on three types of life—of Instinct, of Mind, of Spirit; Freudian factors of the Psyche—the Id, the Ego, the Super-Ego.
4. Concord of ancient and modern views.

13. A reconstruction of the Hormic theory of sentiments.

P. S. NAIDU, Annamalai.

Professor McDougall's analysis of 'Instincts' has undergone steady modification since the publication of the first edition of his '*Social Psychology*'. The first stage is portrayed by the above book, the second by his 'Outlines' and the last by his 'Energies'. In the third stage the threefold analysis into the *perceptive*, the *emotional*, and the *executive* aspects, so convincingly depicted in the '*Social Psychology*' is replaced by a twofold analysis into the *objective* and the *conative* aspects. Since the central aspect, the emotional, is the most valuable contribution of Hormic Psychology, and since it explains several obscure facts of æsthetic experience, we contend that the last stage of Prof. McDougall's theory is a set-back.

It is the vagueness of the concept of *Sentiment* that is responsible for the set-back. When the elements of mental structure, called *instincts* formerly, and *propensities* lately, are organized round *objects* concrete and abstract, what happens is that the *perceptive*, *emotional* and *executive* aspects enter into union both separately and collectively, resulting in what are called '*Sentiments*'. Now Prof. McDougall uses the term '*Sentiments*' for the total resultant formed by the union of the *propensities*, and also for that part of the resultant which is produced by the union of the central parts, the emotions. We must keep the three aspects separate in the final analysis. A clear analysis of the three aspects in the structure of the 'Sentiments' is attempted, for the first time, in this paper. Such a reconstruction restores the original Hormic theory to its legitimate place in Psychology and Aesthetics.

14. On the questionaire method in psychology.

PARSRAM, Lahore.

The questionaire method, of late, has been extensively used in this country for purposes of collecting data in social sciences and in Psychology. The problems about which facts have been gathered by this method have been of the following types:—(1) Social and economic surveys. (2) Opinions of experts and the laymen regarding some of the current social problems. (3) Intimate personal life of the person who is asked to answer the questionaire. Very little has as yet been done to establish the validity and the reliability of the facts collected through this method. Experiments conducted by the author on the method reported in this paper have been on the (1) Stability of the replies to a questionaire and (2) Emotional factors determining the replies. The results of these experiments point to the following conclusions:—Responses of the junior college students, and the neurotics to the 'personality questionaire' and the 'opinion questionaire' are seldom stable. The criterion of a good questionaire is formulated in the light of the experiments.

15. The 'Social-Affective' Concept of Meaning.

S. K. BOSE, Calcutta.

The paper supports a social-affective continuum theory of mental processes and proposes a concept of meaning in social-affective terms. It discusses the affective origin of symbols and tries to prove that sense datum and meaning are same. It expresses the view that a meaningful symbol is a qualitative unit of the affective process externalized. The meaning of a symbol can not be appreciated unless the symbol evokes an emotion due to affective continuity. The term sociality has been used here not as a derivative of the combining of privacies but a kinship of quality between one person and another such that the difference between a man and his neighbour becomes one of degree only.

16. This 'Factory' of Factorial School.

N. MUKHERJEE, Calcutta.

A short account of the Factorial school. The central structure 'G' and its nature. 'S's, and their functions. Recent multiplication of 'S's. Shall Faculty Psychology be dragged out of the grave ?

17. Categories and Concepts in Psychology.

MAJID ZAKARIA, Lahore.

The 'objectivity' in Science in general and in social Sciences in particular cannot be absolute. It is at best a relative concept. A historical survey of the problem shows that concept and categories prevailing at a particular period are largely determined by the cultural milien of the age. The empiricism of the ancient Greeks, the scholastic speculatory methods of the middle ages and the experimental approaches of our own age are indicative of the different cultural forces determining them from behind the screen. The various methods evolved for purposes of psychological investigations can be treated as dealing with different determinants of the dynamic field of our subject matter.

18. Contributions of Abnormal to Normal Psychology.

INDRA SEN, Delhi.

There may be two alternative methods of approach to the problem. 1. To trace the origin of important concepts of Normal Psychology in Abnormal Psychology. 2. To determine whether concepts of Abnormal Psychology are scientifically acceptable. The former is the main, and the latter the supplementary method.

Pragmatic test cannot determine theoretical validity of psychoanalytic principles. One must make a distinction between actual and possible contributions. The proper standard to determine the actual contributions of psychoanalysis so far is the consensus of expert opinion on the subject. This opinion is to be represented by that large group of psychologists who, not belonging to any special school, are described by Woodworth as 'the-middle-of-the-roaders'. Free from prejudice, they are eager to learn whatever they can from anywhere.

The paper concludes by saying that though it must be admitted that psychoanalysis is all still in a state of flux and research, the facts of repression, unconscious and dream causation may be taken as proved.

Education and Tests

19. The psychological basis of creative work in school.

W. M. Ryburn, Kharar.

Creative powers are the possession of all normal people. But certain conditions are essential if children, as they grow up, are to develop these powers.

These conditions are:—

1. *Security.*—A child must have emotional and intellectual security, which is gained when he is given proper affection and knowledge. 2. *Courage.*—Security leads to adventure and the courage to use one's powers. 3. *Objectivity.*—Creative work depends on being able to lose oneself in one's work. Play is of great importance in enabling the child to achieve this. 4. *Freedom.*—For creative work it is essential that a child should have freedom to live his own life and gain his own experience. He must be sincere. 5. *Sense of achievement.*—The child is encouraged in creative work if he is allowed to carry out his own purposes. 6. *Individual Differences.*—If we wish the child to do creative work we must pay attention to the abilities of each individual. We cannot develop creative ability by mass methods. 7. *Activity.*—We must have activity of the whole personality. 8. *Significance in a community.*—The child must be trained in habits of co-operation and to develop the inter-creating mind. Suggestion from parents or teachers has a very great effect on the child.

20. Psychology of the New Education Movement.

J. M. Sen, Krishnagar.

Few schools have as yet been able to bring about a perfect correlation of the curriculum and the child's growing stream of life experiences. Exhibits of children's work have a universal appeal; yet they reveal little regarding the educative value of the activity which produced them. They show what happened to the materials used, but not what happened to the children.

One of the most significant conditions of modern life is that people are having to work more and more together. This fact breeds an insistent demand for the abilities involved in real co-operation, *e.g.*, habits of willing sharing of responsibility, intelligent tolerance of others' ideas, appreciation of others' abilities and contributions, and helpfulness. The attitudes of individuals in the group comprise in (i) consulting the group and accepting the decisions upon problems pertaining to the group, (ii) helping other to help themselves, (iii) feeling responsible for a definite part in group activity, (iv) judging accurately of one's own and others' work, (v) appreciating the abilities of different members of the group, (vi) desiring every one to work in harmony. Whole-hearted effort expended by a number of children working together upon the same activity builds gradually many attitudes and habits which make for genuine citizenship.

21. Measurement of mental qualities.

EMIL W. MENZEL, Bilaspur, C.P.

Many of the most acute problems of the school are those in which better measurement is needed for suggestions of the right solution. The curriculum needs more careful grading, the school starting age needs investigation, disadvantages of children of backward communities need to be measured so also individual differences of pupils and methods and current practices need to be evaluated, etc. Scientific methods of measurement must come to the help of the teacher the traditions of whose profession were set before scientific measurement of mental effects was known. Psychology has contended itself with general educational psychology and has made little attempt to come to grips with local problems of the Indian school system and Indian child psychology by measuring capacities and effects of environment and training.

22. Group Tests of intelligence for Bengali scholars (class V–class X).

H. C. BANERJEE, D. N. ROY, *and* T. P. BHOWMIK, Dacca.

The aim of our work has been (1) to devise a series of Tests of intelligence which may be applied to Bengali scholars from class V to class X, in groups, (2) to analyse the test-material for finding out the validity of the tests and for arranging the items in order of difficulty.

The tests are 10 in number consisting of 158 items in all. All except the 9th test are foolproof. The maximum time including 5 minutes for revision, is one hour.

The tests were applied to 915 students. Test 10, *i.e.* Reasoning proved to be too difficult for the boys of classes IX and X has been left out of consideration. Tentative norms of different classes and the S.D.'s of the scores have been found out. There is gradual progress from class to class except in the case of the two topmost classes where there is hardly any difference. Scores on Test 6 have been more fully analysed and it is suggested that the other tests should be similarly treated.

23. Problems and difficulties of vocational guidance.

M. N. BANERJI, Calcutta.

Value of vocational guidance is recognized in Western countries and attempts are being made to translate the ideas into practical shape with special reference to the needs and conditions of respective countries. A need for this has been recently felt in India and the University of Calcutta has just taken steps to organize Vocational Guidance in a Scheme of Applied Psychology. Attempts have been made in this paper to point out the specific problems and difficulties that, in the opinion of the writer, have to be faced in order to make it successful in India, and specially in Bengal.

24. The medium of examination and instruction.

S. S. JALOTA, Lahore.

The paper reports the results of an enquiry carried on for four years as to the relative efficiency of English, Hindi, and Urdu as the medium of Examination and Instruction. A group Test of general mental ability was applied on 2,500 students from class 8 to 3rd year (only 1,800 are covered in this report), some classes taking English and Vernacular forms and other classes taking only one of them. A thorough statistical analysis shows that (1) success in Matric Examination is largely influenced by mastery over 'English'; (2) Vernacular medium would help general ability and examination in it would give correct estimate of ability; (3) the relative advantage of the vernacular medium decreases as we rise up from the Matric class to 1st and 2nd year class (vernacular scores showing average excess over English scores being 49, 29 and 26 per cent. respectively).

25. Matching method in the study of personality.

S. K. BOSE, Calcutta.

Written character sketches of five persons, touching on ten traits, together with their photographs (quarter size) were presented to three judges for matching. Correlation has been calculated with the help of a new technique.

26. Reliability of repeated grading of English essays.

H. C. BANERJEE, Dacca.

In this article an attempt has been made to establish by experiments that repeated grading of the same essay in English by the same set of experienced teachers and headmasters after a long interval of time is very unreliable whatever may be the examining technique followed to ensure accuracy.

Thirty-one boys of Class IX of a High English School at Dacca were asked to write an essay in English. The subject was, "A short description of my Home." These essays were marked by ten experienced teachers and headmasters of High English Schools first by general impression and then after six months according to a marking scheme. The fallibility of human judgment, even when it is the same person judging the same material at the same time or at different times, has been strikingly shown. The estimates of examiners were, in general, found to be more inconsistent when the essays were marked by impression than when they were marked by a detailed scheme.

27. Pupils' preference for school subjects.

S. P. CHATTERJEE, Calcutta.

The author investigated this problem first in London and came to some interesting conclusions. He has followed up with further investigation recently in some High Schools of Calcutta. The results are classified according to the age range of the boys.

28. Some aspects of measurement of Intelligence.

N. MUKHERJEE, Calcutta.

After referring to the value of Intelligence measurement for systematic education and vocational guidance, the paper points out that it would lead to national economy through the avoidance of unproductive educational efforts in the case of mental deficients. It closes with a discussion of the social effects of different grades of intelligence and their relation to our existing social and economic orders. This means a need for some measure for the protection of the mentally inferior.

29. Application of Dearborn Formboard tests.

D. AGARWALLA *and* M. SAMANTA, Calcutta.

An attempt is being made by the authors of this paper to standardize the Dearborn Formboard Tests on Indian boys and girls. The Tests have been applied on 1,000 cases. A preliminary report is submitted here.

Psycho-analysis and Psychiatry.

30. A psychoanalytical study on marriage.

W. A. Hobson, Allahabad.

The object of this paper is to show from the psychoanalytical point of view the nature and function of true marriage of heterosexual union between man and woman. This involves a study of the meaning of homosexuality and autoeroticism or Narcissism.

Three preliminary points are dealt with before the main thesis appears: 1. That heterosexual union is primary and fundamental and that homosexuality and autoeroticism are degenerative processes. 2. That in the course of development the sexual impulse passes through two phases, the facial and the genital, and that this occurs twice in the life of the individual, namely, in the first four years after birth and the first four years after puberty. 3. That the sexual act is always a dual and reciprocal transaction. These preliminary points being considered, the rest of the paper goes on to provide a comprehensive survey of all the factors which enter into the sex life of man both on the normal and abnormal sides.

31. Modern treatment of Schizophrenia.

H. M. Selzer, Lahore.

Report of tho two most recent therapeutical applications in psychaitry, the shocktreatment with Insulin and the convulsive treatment with Cardiazol.

The action of Cardiazol and Insulin are still unknown, though their therapeutical efficiency cannot be doubted. In this paper the possibilities of the dynamic factors, which may influence the recovering of schizophrenic patients, like incretoric dysfunctions, emotional influences, colloidoclastic changes of the organism, prolongated sleep, and anatomical alterations in the central nervous system, are discussed.

32. Psychological investigation of insane murders.

R. S. M. Sarma, Lahore.

This investigation of 'insane' murders brought to surface some important problems. (1) This crime is comparatively rare in females. The proportion of females to males who committed murders was less than 1 : 20. (2) A large proportion of the victims consists of relatives and friends of the murderers. (3) All the insane murders are not impulsive purposeless acts but some of these are committed with definite object in view, *e.g.*, as a result of provocation or for purpose of revenge, self-defence, etc. But the purpose is based on delution of the insane mind and not of reality. (4) Lastly, there are murders which are prompted by a pure homicidal impulse. The person does it, because he cannot help it. Such a homicidal impulse is most probably released by Regression from the collective Unconscious. In our collective unconscious we have traces of experiences of our ancestors in dark ages when one male not only killed another to possess his female partner but even killed his own male progeny in sexual jealousy.

33. Kretschmer's theory and Behaviourism.

R. M. Loomba, Delhi.

Kretschmer's theory of constitutional types is gaining in importance due to its admitted practical value and recent advances in our knowledge about diseases, heredity and glands of internal secretion. It is already being applied to problems of psychiatry, vocational guidance and education, crime and legal procedure and industry.

After referring to some points of contact between Behaviourism and Kretschmer's theory, the paper proceeds to enumerate and discuss certain significant points of difference between them. One stresses the Environment factor and the stimulus, and conceives of a one-to-one parallelism between reaction and antecedent. The other stresses the Heredity factor, the germ cell and the bodily constitution, and conceives of the determining influence of specific inherited disposition. In spite of affinity between the two, one opposes the other in fundamental points.

34. Chemiotherapy of Schizophrenia.

D. SATYANAND, Lahore.

It is very important to find out special indications of each method of treatment. The principles on which choice of cases depends. Treatments used in the Punjab Mental Hospital are: Pyrogenesis; Prolonged Narcosis; Convulsion Therapy; Insulin Therapy. Routine procedure followed include physical and psychological history, physical and psychological examination (inc. Clinical), full list of symptoms, progress report. Special procedure consists of the four kinds of treatments mentioned already. Important details about the use of drugs.

The value of psychological factors and of general restorative factors common to all the four methods of treatment is discussed. Psychiatric treatment is still indespensable.

Pyrexial therapy indicated in mild, and Analeptic therapy in severe cases of catatonia, depression and stupor; Prolonged Narcosis indicated in mild, and Hypo-glyeæmic treatment in severe cases of hallucinations, delusions and excitement.

35. A case of temporary loss of memory.

K. P. CHATTOPADHYAY, Calcutta.

The writer describes and discusses a case of temporary loss of memory due to conflict between two powerful tendencies both based on the instinct of Self-preservation.

36. Therapeutical indications of frigidity in women.

H. M. SELZER, Lahore.

Frigidity in women is generally the consequence of external factors precipitating a pre-existing subconscious complication. From the medical point of view it should be tried to get the knowledge of primitive psychological experiences to be able to understand the more superficial psychical complications, specially those combined with technical defects, unorganized married life, anatomical changes, organic diseases, chronic intoxications. The general practitioner is the first to see these patients and the right diagnosis must be the beginning of a treatment. Proper handling of the psychical complications, rooted deeply in the subconscious, must be left to (entrusted to) an experienced psychotherapeutist, as a psychological error may aggravate the condition. A clearer understanding of these psychological factors in the patient should be emphasized in the training of medical students.

37. Attempt at interpretation of a Garo dream.

T. C. SINHA, Susang.

In this paper a dream of a Garo Laskar (Local Head appointed by Government) has been recorded and an interpretation has been attempted on Freudian basis. The symbolism found in the dream and the mechanism of dream formation are exactly same as in dreams of civilized peoples.

38. The way to sublimation.

M. SAMANTA, Calcutta.

After referring to the relation of Instinct and Sublimation, the paper discusses the role of Sublimation in normal and abnormal psychic life. It next analyses the conditions and process of sublimation and ends by pointing out ways by which this can be effected for educative purposes.

39. Instincts in psycho-analysis.

N. K. MAJUMDAR, Calcutta.

The psycho-analytic schools use different concepts of instincts for purpose of ultimate explanation of human behaviour. The paper attempts to understand this difference and to make a critical evaluation of the basic concepts.

40. A contribution to the study of conversion hysteria.

I. LATIF, Lahore.

In this paper an attempt is made to explain the mechanism of psychogenic inhibition. As illustrative material the case of a musician is briefly described. The case has a peculiar feature of clinical interest in that whereas the functional impairment of his finger-movements had resulted in his inability to play upon the *sitar* and the *tablas*, the patient, nevertheless, displayed no functional inhibition in playing the harmonium.

Social Psychology.

41. Religious experiences of Muhammad.

M. ASLAM, Lahore.

The psychology of religion is best advanced by a systematic study of the experiences of first-rate religious personalities, founders rather than followers of religious traditions.

This paper, accordingly, draws on original sources and describes with a minimum of comment, the experiences of the Prophet of Islam. Types of experiences are selected depicting the varieties of the Prophet's experiences as well as the stages of his life which are psychologically interesting.

42. Sensory aids in mystic life.

RAJ NARAIN, Lucknow.

In some forms of mystic culture, *e.g.*, Buddhistic, *sensory stimuli* are employed for inducing mystic consciousness. After a certain stage it is replaced by its *image*. In the next stage the mystic is to concentrate upon the *meaning* of the sensory stimulus employed before. After these stages a stage of ecstasy supervenes.

Where the above devices are not employed, sensory experiences themselves arise during the course of mystic realization. These sensory experiences are *milestones* in mystic introversion.

An attempt will be made in this paper to determine the *psychological significance* of sensory phenomena in the development of mystic life and consciousness.

43. Social psychology and rural reconstruction.

J. C. Heinrich, Sheikpura.

The present paper is an attempt to link up principles of Social Psychology with actual field work in rural reconstruction.

An important problem to be tackled is that of 'bridging the gap between the experiment station and the cultivator'. This is in turn connected with the problem of human personality and its re-education, specially that of dealing with the apathy of the small farmer and his resistance to change. The fundamental problem in Punjab rural reconstruction, however, is the re-education and development of a social outlook in a large group of people at the bottom of the economic and social scale in the villages.

After reference to an American Government Programme on the subject, the paper gives an account of a project of rural reconstruction carried in a part of the Punjab under the leadership of the author for the past six years. Some practical experiences and results of psychological interest are indicated.

In closing, mention is made of two problems on which continued experience and research need be made. One is on the fundamental value of religion in the rural reconstruction programme. The other is on the constructive social utilization of the energies inherent in communal tension.

44. The culture of emotions in mystic life.

Raj Narain, Lucknow.

Culture of emotions is an essential feature of the *bhakti* cult of India, and of Buddhist *jhana-yoga*. It is also mentioned in the *Yoga-sutras*. Even western mystics speak of it in their works.

Culture of emotions in mystic life has two aspects. The first consists in providing the psychophysical conditions necessary for the emotion cultivated; the second, in conceiving or representing in imagination a situation stimulating the growth of emotion.

An attempt will be made in this paper to understand the psychological basis and significance of the culture of emotions in the economy of mystic life.

45. The utility of psycho-analysis in social anthropology.

H.R.H. Prince Peter of Greece.

The explanations of origin of many customs as given by Social Anthropology and explanations of cultural differences as given by the science of Ethnology so far are far from satisfactory, on account of the fact that these do not go into the emotional life of man. The discoveries of psycho-analysis in recent years have very greatly increased our knowledge on this subject, and have thereby enabled us to understand these and many other problems of Social Anthropology more satisfactorily.

The paper next refers to some of the more important principles of Psycho-analysis, e.g. the interaction of Id, Ego and Super Ego; factors and stages of mental development; and the Oedipus Complex.

In applying psycho-analytical principles for the interpretation of data of Social Anthropology, one important caution should be kept in view. These principles have been reached on the basis of analytical materials in Western countries and may not be applicable to conditions of life to be found in other types of social organization and in other parts of the world. One should, therefore, keep himself strictly down to direct observation and try to make direct use of the psycho-analytical method instead of making deductive applications of psycho-analytical theories. The paper concludes by strongly emphasizing the very great value of psycho-analysis in the field of Social Anthropology and by recommending it to research worker in this field.

46. The psychology of the beggars.

A. C. Bhatia, Lahore.

To understand the beggar rightly, one must examine the various psychical forces which goad him on to his profession:—Special family relationship, sex urge, emotional behaviour combined with strong determination, wandering mania, inferiority complex, hereditary instinct, fatalism, inability to respond to moderate environmental stimuli, loose social ties, effects of bad physical conditions, working of unconscious mind, permanent adjustment to a wrong type of particular group, etc. All these forces have a concomitant detrimental effect upon the minds of the beggars and make them anti-social. One cannot ignore, however, the economic motive as a dominating factor. A series of desire and wish manifestations responsible for maladjustments to life and produced by motivating forces are pointed out. The group form of beggar life constitutes a serious difficulty in our efforts to deal with the problem practically. Healthy adjustment is possible through institutions like Industrial Homes, Poor Houses, Receiving Centres, Refuges, etc.

47. Psychological aspects of some customs of the Sansi tribe.

A. H. Jameel Alawi, Gujranwala.

The paper is a study from the psycho-analytic point of view of some customs and beliefs of a subsect of the Sansi tribe, a registered criminal tribe of the Punjab. The name of the subsect is 'Bhaid Kuts' (sheep killers). Living a vagrant and hunting life, they eat all sorts of animals except the sheep which is believed to be the ancestor of the tribe, but which they kill and eat on ceremonious occasions. The primitive customs are shown to be related to the Oedipus Complex. Ambivalent attitude is displayed not only with regard to the sheep, the unconscious symbol of the father, but also in the matter of their burial custom.

The tribe has a peculiar method of deciding petty matters. They meet in a circle with their chief in the center with a 'bhala' in hand. It means power and penis. If one is to speak he must hold it. A personal dispute is terminated by the chief by breaking a straw with sword. These customs are interpreted in terms of the castration complex.

Though there is a strict rule about incest, women very commonly prostitute themselves. The influence of the Oedipus Complex is very clearly seen in the 'Daruda' custom, according to which on the death of the mother the son puts coins in her mouth and keeps all sorts of toilet requirements by her body in the grave and finally lays a long stick, 'bhala' in it. He gives a feast because he has given his mother a precious gift e.g., a 'bhala,' or his staff.

In a word, the primitive customs of the tribe afford beautiful illustrations of the Freduian theory of totemism and Oedipus Complex.

48. A psychological interpretation of the primitive pubescent ceremonies.

JAGDISH SINGH, Lahore.

The two widely prevalent puberty ceremonies of the primitives are picked out, torturing in the case of boys and seclusion at first menstruation in the case of girls. Various theories explaining these rituals are examined and evaluated.

Child Psychology.

49. A study of the free drawings of an eight year old child.

K. L. SHRIMALI, Udaipur.

An attempt has been made in this paper to study some emotional peculiarities of child nature with the help of phantasies as revealed in a series of free drawings of an eight year old child belonging to the Preparatory Class of the Vidya Bhawan, Udaipur. The boy was entirely free as to choice of his theme and also as to the mode of development of it. The present study is based on the analysis of 50 consecutive drawings spread over 9 calender months.

Certain persistent themes drawn upon are pointed out and an attempt has been made to interpret the drawings on psycho-analytical lines partly on the basis of supplementary conversation with the child and partly on the basis of our knowledge of symbolism in dreams. The drawings properly interpreted give valuable information about the emotional life of the child specially as it is related to the members of his family.

50. A psychoanalytical theory of play.

S. M. MOHSIN, Muzaffarpore.

The paper begins with a critical review of four principal theories of play. The Preparation theory is examined at length. In view of fundamental characteristics of the two processes, play cannot be said to prepare for work.

A definition of play is attempted on psychoanalytical lines. It is suggested that it is the symbolic gratification of repressed libido trends through active manipulation of objects and situations. Reference is made to facts of infantile sexuality. Plays and dreams are shown to be analogous. The suggested theory explains both constructive and destructive types of play.

51. A study of anger in children.

SRIMATI B. NAGARATNA, Mysore.

A study of the anger behaviour of 31 children, through parents' records, was made on the basis of the instinctive drives thwarted. The children are all of the ages of 10 to 66 months. Three most important sources of anger were, thwarting of the play impulse, the self-assertive impulse, and the food-seeking impulse. Self-assertion, curiosity and the display impulse showed development with age, whereas food-seeking and appeal impulses showed decreasing frequency with age. The expressions of anger were largely primitive and un-directed. The proportion of 'directed' behaviour increases with age. The increase is also noticed in indirect attacks. The parents were more gentle in handling the outbursts of younger children, usually resorting to soothing, coaxing, diverting the attention, and offering pleasant emotional appeals such as giving sweets, praising, rewarding, etc.; whereas coercive methods such as beating, deprival of privilege, exclusion from society are resorted to more often with elder children.

The paper concludes by pointing out that educational bearings of the results.

52. Behaviouristic peculiarity of feeble-minded children.

N. C. Bagchi, Calcutta.

While acting for sometime as the Superintendent of Bodhana Home for the feeble-minded children, Bengal, the author of the paper made systematic observation (in collaboration with Prof. H. P. Maiti) of behaviour and emotional characteristics of fifteen mentally deficient boys and girls of the institution. An attempt has been made to present the characteristics from a comparative standpoint, and suggest their psychological significance.

Physiological Psychology

53. Electrical rhythm from the intact human brain.

B. K. Bagchi, Calcutta.

Since Berger's work reported in 1929 it has been possible for the first time in the history of science to record spontaneous electrical oscillations from the intact human brain and certain changes they undergo under different psychological and physiological conditions such as vision, concentrated attention, visualization, movement, over-oxygenation, etc. Low frequency, high amplification radio-valve amplifiers are used in connection with an oscillograph for recording purposes. In addition to a general survey of the work this paper reports experiments in which it has been found that the dynamic electrical activity of the brain which is momentarily disturbed by a stimulus attack in the form of light or sound can recover from the effects of the attack, *i.e.* can regain its pre-stimulus intensity or amplitude, more or less, if the attack is made continuous, or repetitive in certain cases. Results obtained in the following situations will also be reported: continuous mental arithmetic, slight repetitive muscular movement, successive startle stimuli, etc. Psychological possibilities of this type of work will be explained.

54. Psychology of cardiac pain, its relation to sudden death and its anatomical basis.

J. N. Maitra, Calcutta.

1. What is pain, what causes a pain and what are the receptive organs of pain stimulus.
2. How a pain impulse runs from an organ producing pain to the pain reception centre.
3. Cardiac pain and deep pain caused in other viscera and their relation to death.
4. Deaths sudden, (*i.e.* without notice of pain) and deaths with pain.
5. Pain of death *versus* pangs of death.

55. Human temperaments.

W. Burridge, Lucknow.

The paper begins by pointing out that it is necessary to correlate psychological and physiological phenomena. We have failed in this work largely because traditional physiology, based on the frog's muscle-nerve preparation, conceives of the nerve-cell as an 'inert' structure and having only one source of energy. The author advances a new theory. A nerve-cell possesses two sources of energy and is rhythmical in activity. His view is partly supported by Adrian.

The author next proceeds to show how with the help of his new theory a satisfactory physiological interpretation of the four classical types of temperament is possible. The individual's temperament indicates the normal nature of the processes of a special group of nerve-cells of the brain ('Ego' group).

Proceedings of the Twenty-sixth Indian Science Congress

PART IV—LATE ABSTRACTS, ERRATA AND ADDENDA, DISCUSSIONS, LIST OF MEMBERS AND INDEX

CONTENTS

		PAGE
1.	Late Abstracts	1
2.	Errata and Addenda	12
3.	Discussions	13
4.	List of Members	58
5.	Index	95

1. LATE ABSTRACTS

Section I, Mathematics and Physics.

32(*a*). The absorption spectra of single crystals of Rare Earth Salts under polarised light.

D. C. Chakravarti, Calcutta.

The absorption spectra of single crystals of rare earth salts of the types $M_2(SO_4)_3 \cdot 8H_2O$, $M(C_2H_5SO_4)_3 \cdot 9H_2O$ and $MCl_3 \cdot 6H_2O$, have been studied over a wide range of temperatures, using polarised light. Experimental data are given in the paper for the directions and intensities of polarisation of all the prominent absorption lines of the crystals.

As is well known, under the influence of the strong internal electric fields acting on the M^{+++} ion in the crystal, each absorption line of the *free* M^{+++} ion splits up into its appropriate Stark components. Taking any such group of absorption lines which originate from the same line of the free ion, we find that many of them are strongly polarised, some along one and some along another of the principal planes of the optical ellipsoid of the crystal, showing that the internal fields which produce the Stark splitting should be strongly asymmetric. This result is in agreement with the strong magnetic anisotropy observed in these crystals by Krishnan and Mookherji.

32(*b*). Absorbability of scattered X-rays.

H. K. Pal, Calcutta.

The absorbabilities α_ϕ of a heterogeneous beam of X-rays scattered in different directions, given by the angle ϕ between the scattered ray and the primary ray, have been compared with $\alpha_{90°}$ for different scatterers. It was found that—

(1) At $\phi = 150°$ (in the region of backward scattering) $\alpha_\phi > \alpha_{90}$ invariably, as required by the Compton theory of scattering for homogeneous radiation. The agreement was of the right order of magnitude.

(2) In the forward direction, the experimental results may be classified under 3 distinct types, depending on ϕ, the nature of the scattering material, the exciting voltage and how much the incident primary beam has been filtered.

(*a*) $\alpha_\phi < \alpha_{90}$ as suggested by the Compton theory. The agreement was qualitative only.

(*b*) $\alpha_\phi = \alpha_{90}$

(*c*) $\alpha_\phi > \alpha_{90}$

Observations (*b*) and (*c*) superficially appear to contradict the Compton theory. This anomaly may be explained as due to 'excess scattering' arising out of interference effects, which superposes on the Compton effect another effect of opposite sense.

Results of type (*a*) are yielded by paraffin wax and carbon, type (*b*) by filter paper, and type (*c*) by aluminium and sulphur, used as scatterers.

32(*c*). A study of the energy distribution of scattered X-radiation.

H. K. Pal, Calcutta.

The intensity distribution of X-radiation scattered from various substances has been studied. Employing heterogeneous radiations extending over a wide range of wave lengths, the ratio I_{ϕ}/I_{90} where I_{ϕ} = intensity of scattered radiation at an angle with the primary beam, has been determined experimentally for various angles from $\phi = 20°$ to 150°. The informations obtained are:

1. In the backward direction—
   - (*a*) The ratio I_{ϕ}/I_{90}, though approximating to the value $(1+\cos^2\phi)$ for long waves, is invariably less than that given by this simple law.
   - (*b*) For a particular wave length, the deficiency of the ratio I_{ϕ}/I_{90} below $(1+\cos^2\phi)$ is independent of the nature of the scattering material.
   - (*c*) The deficiency of the ratio I_{ϕ}/I_{90} below $(1+\cos^2\phi)$ increases as the wave length decreases.
2. In the forward direction—
   - (*a*) The ratio I_{ϕ}/I_{90}, though approximating to $(1+\cos^2\phi)$ for short waves, is invariably greater than that given by this simple law.
   - (*b*) For a particular wave length, the excess of the ratio I_{ϕ}/I_{90} over $(1+\cos^2\phi)$, depends on the nature of the scattering material, increasing with an increase in its atomic number.
   - (*c*) For a particular scatterer, the excess of the ratio I_{ϕ}/I_{90} over $(1+\cos^2\phi)$ decreases with the wave length.
   - (*d*) For a particular wave length and a particular scatterer, the excess of the ratio I_{ϕ}/I_{90} over $(1+\cos^2\phi)$ decreases as ϕ increases.

32(*d*). A study on the polarisation of X-rays.

H. K. Pal, Calcutta.

The percentage polarisation *P* of a beam of X-rays, defined as usual by the quantity $100\,(I_A-I_B)/(I_A+I_B)$, where I_A and I_B represent the intensities of the scattered X-rays in a direction perpendicular to the primary beam, when the cathode stream is perpendicular and parallel respectively, to the scattered rays in question, was determined with a Müller tube having a tungsten anticathode. It was observed that for a heterogeneous beam—

(1) *P* does not depend appreciably on the nature of the scattering material (paraffin wax and filter paper were tried).

(2) *P* gradually increases as the excitation voltage is reduced, as shewn below.

Kilo Volt (Peak)	100	80	70	60	50	40	30
Mean *P*	1·3	2·1	2·8	3·25	4·6	6·25	8·8

(3) At a constant voltage, *P* gradually increases as the primary beam is hardened more and more by filtering as shewn below.

Thickness of aluminium filter in cm.	0	·054	·316	·632	·948
Mean *P* at 100 K.V. (Peak)	1·3	1·4	1·8	2·5	2·9
,, ,, ,, 80 K.V. (Peak)	2·1	2·25	3·1	3·95	

95. Paramagnetic studies on single crystals.

K. S. KRISHNAN, A. MOOKHERJI *and* A. BOSE, Calcutta.

Studies on the magnetic anisotropies of paramagnetic crystals are of interest because of the variety of information one can obtain from them under favourable conditions, on such widely different topics as (1) the magnitude and the asymmetry of the internal electric field acting on the paramagnetic ion in the crystal; (2) the geometry of distribution of the negatively charged atoms immediately surrounding the paramagnetic ion, and hence the co-ordination number of the ion; (3) the magnitude of the Stark-separation of the energy levels of the ion in the above field; (in the special case when the paramagnetic ion in the crystal is in the S-state, the Stark-separation of its levels is naturally feeble, and it plays an important part in determining the thermal behaviour of the crystal at very low temperatures, in the neighbourhood of 0·1° K.); (4) the strength of coupling between the orbital and the spin angular momenta of the electrons in the incomplete shell of the ion; etc. These various aspects of paramagnetic studies are illustrated from the results of extensive magnetic measurements on salts of the rare earth and the iron groups, over a wide range of temperatures.

96. Temperature variation of the magnetic anisotropy of $CuSO_4 \cdot 5H_2O$.

K. S. KRISHNAN *and* A. MOOKHERJI, Calcutta.

Copper sulphate pentahydrate is for many reasons a very suitable crystal for verifying some aspects of the theory of paramagnetism in crystals developed recently by Van Vleck and others. The explanation of the magnetic anisotropy as arising ultimately from the asymmetry of the internal electric fields acting on the paramagnetic ions in the crystal is satisfactorily verified. From the observed anisotropy of the crystal as a whole, the anisotropy of the Cu^{++} ion in the crystal under the asymmetric electric fields due to its neighbours is calculated. Its variation with temperature is followed from the temperature of the room to that of liquid oxygen, and it shows some features of interest from the point of view of the new theory.

97. The structure-sensitiveness and the Temperature-dependence of the abnormal unidirectional diamagnetism of graphite crystal.

K. S. KRISHNAN *and* N. GANGULI, Calcutta.

Graphite crystal has an exceptionally large diamagnetic susceptibility along the normal to the cleavage plane of the crystal, about -22×10^{-6} per gram at room temperature, whereas along directions in the cleavage plane the susceptibility is only $-0{\cdot}5 \times 10^{-6}$, which is nearly that of diamond. The former susceptibility is extremely sensitive to changes in the structure of the crystal, brought about for example by 'swelling', or by oxidation, or by treatment with alkali vapours, etc., and also to particle size and to changes in temperature.

98. The figuring of a 24″ reflector made in India.

H. PARAMESWARAN *and* S. HARIHARAN, Trivandrum.

The paper gives an account of an optical work undertaken and finished to satisfaction at the Madras Presidency College, namely, the grinding, polishing and figuring of a 24″ reflecting telescope mirror of about 12′ focal length. The procedure adopted to correct zone after zone and the vertical testing arrangement with special fittings to ensure freedom from vibrations and disturbing air currents is described. The mirror has also been tested by focograph and Hartmann methods. They indicate a very satisfactory condition for the parabolic figure of the mirror with but very minor zonal irregularities. A short focus mirror of 1′ aperture and 3′ focal length made for photographic work adopting the same procedure has come out very successfully.

99. The making of a 6″ long focus (15′) achromatic objective.

H. Parameswaran *and* A. V. V. Krishna Rao, Trivandrum.

The paper gives an account of the design and construction of an achromatic lens for solar work to give a fairly large and bright image of the sun. The preparation of the test plates, their testing and figuring as well as the difficulties encountered in the finishing and testing of the assembled lens to satisfaction are described.

100. A note on the method of parallax and the resolving power of the eye.

S. B. Mathur, Delhi.

The paper describes some observations made to determine the accuracy obtainable in ordinary laboratory experiments on the method of parallax, and its relation with the resolving power of the eye. To avoid complications, a concave mirror was fitted on a precision optical bench.

Besides dynamical, statical observations i.e., the absence of parallax being judged with the eye fixed and without moving it, were taken. The results show that the resolving power of the eye K varies with the distance D between eye and pin, and attains nearly constant value of 40″ when D is increased to about a metre. This is near the usual resolving power of the eye. For D equal to about 10 cms., K is abnormally large. On the whole our observations show that the accuracy attainable in the method of parallax under ordinary laboratory conditions is limited by the resolving power of the eye itself. It shows therefore that in the method of parallax the movement of the eye is not essential—it does not impart any increased accuracy. For increasing the accuracy the perpendicular distance of the eye from the optical axis should be as large as possible and D be kept near the least distance of distinct vision (about 25 cms.).

Section II, Chemistry.

141(*a*). Hydrolysis of esters in heterogeneous systems.

D. D. Karvé *and* V. L. Mehendale, Poona.

In continuation of previous work done in the Fergusson College Laboratory (Cf. Karvé and collaborators, *Proc. Ind. Sc. Congr.* 1937, 1938) the velocity of hydrolysis of benzyl, butyl and *iso*-amyl acetates dissolved in different non-aqueous solvents by aqueous hydrochloric acid was determined under different experimental conditions. The benzyl acetate hydrolysis appears to be a purely heterogenous reaction while the other two are mixed homo-heterogeneous reactions. The temperature coefficients of the reactions at 26° and 36° have also been determined.

141(*b*). Hydrolysis of some aromatic and aliphatic nitriles by sulphuric acid.

D. D. Karvé *and* D. V. Gharpure, Poona.

The velocity of hydrolysis of benzonitrile, benzyl cyanide, *o*-, *m*-, and *p*-tolunitrile, *p*-chlorbenzonitrile and *p*-brombenzonitrile as also of acetonitrile, propionitrile, *n*-butyronitrile, *n*-valeronitrile and isovaleronitrile dissolved in acetic acid by means of varying concentrations of sulphuric acid solutions was determined. In each case the proportions of total and hydrolysed nitrile to the amide were separately determined by means of the modified form of the procedure of Bouveault, (*Bull. Soc. Chim.*, 1892; (3), *9*, 368). Further the temperature coefficient of the reaction has also been determined in the case of two typical nitriles.

Section III, Geology.

6(*a*). Experiments on blending and swelling properties of some Jharia coals.

N. N. Chatterjee *and* B. C. Chakravarty, Calcutta.

(*a*) Blending:

Investigation was carried out with coal samples from five different seams (Nos. XI, Ekra; XII, Ekra; XIII, Gopalichak; XIV, Ekra; XV, Central Kirkend).

For blending pure quartz sand was used. In every case one gram of the mixture (coal and sand) was taken. The strength of the coke in each case was determined by the standard method. It was found by these experiments that the seam Nos. XI, XII, XIII, XIV and XV took as much as 30% sand without losing any strength of caking and swelling. The binding capacity of these coals, however, remained unaffected up to 50% of sand but the swelling gradually diminished.

(*b*) Swelling properties and period of heating.

The above experiments on blending were supplemented by some investigations on swelling properties. The method which was advocated by Cummings and Ivision was followed. The tests were carried out for periods of heating increasing by half minute intervals. It was found that the time of maximum swelling was not same for all the coals and it usually occurred within 2½ minutes. The maximum swelling for the coals of five seams Nos. XI, XII, XIII, XIV and XV occurred at 1½, 2, 2, 2½ and 1½ minute periods respectively. It was noticed that the coals swelled to a marked degree and after gradual shrinkage in volume they reached the final stable volume. In the case of seam No. XII, however, a slight decrease in volume occurred followed by a small increase during the final stage of coking.

Section V, Botany.

13(*a*). Leaf spots of *Agave americana* Linn. caused by *Diplodia agaves*.

N. S. Madan, Lahore.

The disease of *Agave americana* Linn. caused by *Diplodia agaves* has been described. Pure cultures of the causal fungus have been obtained in Potato Glucose agar and morphology of the fungus has been studied in the host as well as in culture. Germination of spores from the material and three months old culture has been studied in hanging drop cultures. Inoculation experiments have been performed showing that the fungus is a wound parasite. Physiology of the fungus including the effect of different media variations of asparagin, different hydrogen-ion concentrations, and other environmental factors has been studied and the results are shown in graphs and charts.

13(*b*). *Pestalozzia phoenicis* on *Phoenix dactylifera.*

N. S. MADAN, Lahore.

A disease of *Phoenix dactylifera* due to *Pestalozzia phœnicis* has been described. The morphology of the fungus in the host has been studied. The causal organism has been isolated and cultural studies made. The growth of the fungus under different physiological conditions has been noticed. Successful artificial inoculation experiments showing the pathogenocity of the fungus have been made.

Section VI, Zoology.

55. Breeding habits of *Anopheles sundaiens Rodenov.*

P. SEN, Calcutta.

In India the species *Anopheles sundaien* was long known as a virulent malaria carrier in the coastal tracts of Bengal such as Sundarbans and part of Khulna as also from the Andaman Islands. But in recent years the species has invaded inland areas and at the present day the species breeds freely in various parts of the districts of Khulna, Bakerganj, Noakhali, 24 Parganas, Howrah and Hooghly. The species has since been recorded from the Chilka Lakes and the adjoining localities in Orissa by Senior White.

The species although normally breeds in brackish or saline water has in recent years taken to breeding in practically fresh water in the environs of Calcutta. The species breeds in open sunny places, shade being detrimental to normal development of the species. These breeding places usually lie along the banks of tidal rivers in low-lying areas, swamps and borrow-pits which are only touched by high tides but are not flushed by the river water. Most of the breeding places favoured by the species flourish in aquatic vegetations such as Hydrilla, Enteromorpha, Oscillatoria and certain similar algæ. The species also breeds in fish ponds in the salt lakes to the east of Calcutta in the presence of fish as has been noted from Java. Borrow-pits along Railway embankments are also favourable breeding grounds of the species.

56. An Arhynchobdellid leech, *Hæmopis sp.* from Kashmir (India).

M. L. BHATIA, Lucknow.

In 1936 Prof. Bahl collected three specimens of this leech from pools and water channels in Pahlgam and handed over to me for identification and study. The discovery of this leech in Kashmir is the first record of the genus *Hæmopis* from India.

Dissections and examination of the gut contents revealed the fact that the form is carnivorous and cannibalistic. The corp is packed with earthworms and leeches swallowed entire. The worm appears to have a special liking for a leech *Erpobdella octoculata*, which is also very commonly met with in the same locality.

The alimentary canal of *Hæmopis* differs from that of the ordinary blood-sucking leeches. The jaws are very weak, bear two rows of teeth (distichodont), the pharynx is long and muscular extending up to segment IX. The thin-walled crop is slender, *straight* tube extending up to somite XVIII. There are no paired diverticula of the crop as are characteristic of blood-sucking leeches. A pair of simple tubular cæca arise from the posterior end of the crop and extend up to segment XXII. The crop opens into stomach which is lined with numerous anastomosing folds. The intestine and rectum are simple and the anal aperture is on the dorsal side.

Genitalia and other morphological details are included in the paper.

57. *Glossiphonia reticulata*, from the mantle of *Lamellidens*, the common freshwater mussel of Lucknow.

M. L. BHATIA, Lucknow.

The previous diagnosis of this leech is based upon a single individual from Jullundhur (Punjab) in the possession of the Indian Museum Calcutta. Two specimens were collected from freshwater mussels brought from the River Gomti, at Lucknow, which show more anatomical details than those previously recorded.

There are two pairs of eyes. The crop has seven pairs of branching diverticula. There are six pairs of testes. Other morphological details are included in the paper.

Section VII, Anthropology.

27. Bengal coiled baskets.

K. P. CHATTOPADHYAY, Calcutta.

The author classifies the types of baskets found in Eastern Bengal and discusses the technique of sewing and making such baskets which, he says, is linked with carpentry.

Section VIII, Medical and Veterinary Research.

32(*a*). Serology in Radiation Therapy.

M. J. S. PILLAI, Madras.

Fœto-maternal factors—stimulation by fœtal organism, the demand and response of the maternal organism—the supply. The rapid development of the nervous system followed by the evolution of other systems, the controlling centres preceding the development of the controlled organs.

Formation of the pituitary—the Governor of the Endocrine system, preceding the development of the associated endocrine glands comprising the system. The harmonious inter-action of one or more on the remaining ones, jointly and severally, is involved in the evolution of the organism, the energising and building factors predominant in the young tissue, reaching the acme in the adult, followed by decline and decay.

To stay the deterioration, the suggestion for the introduction of the fœto-maternal products contained in the serum of pregnant woman, is made.

The application of these factors, in the treatment of Tuberculosis and Cancer, in Radiation Therapy, is also suggested.

Considering the prevalence of the Law, that the higher the specialization, the earlier the deterioration, the artificial introduction, of constructive and controlling elements of the maternal blood to replace those of the endocrine system, which were exhausted by introducing the serum of pregnant women, in deteriorating phenomena, including the onset of malignancy, deterioration and death, is recommended.

It is suggested that Radiation Therapy in the control of aberrant and malignant tissues can be assisted by pregnancy serum, which harmonizes the growth and controls the evolution of the embryonic tissue in normal pregnancy; the malignant tissue is almost identical with the embryonic tissue with the difference that the former is subject to harmonious evolution, while the latter is independent of the control of the hormones in the (maternal) serum.

43(*a*). On a new feather mite paraphagistic on the Indian domestic fowl (*Gallus bankiva murghi*).

M. Abdussalam, Lahore.

The new mite described in this paper was found to be epizoic on two young chickens at Mukteswar (Kumaun, 7,500 feet above sea-level) in September, 1935. It falls under the genus *Rivoltasia Canestrini* and comes nearest to *Rivoltasia bifurcata* (Rivolta) from which, however, it differs in that the notch on the tarsus of the fourth leg of the male bears a hair instead of a tooth, and, that the tibia of the fourth leg of the female bears no tubercle. It has thus been considered a new species and named as *Rivoltasia karamellahiei* n. sp.

No ill effects were observable on the skins of the chickens on which this mite occurred. Pathogenicity of the other closely allied mites found on the domestic fowl has also been discussed in the paper.

43(*b*). The occurrence of equine nasal bot, *Rhinœstrus purpureus* (Brauer, 1858) in India.

M. Abdussalam, Lahore.

The occurrence of *Rhinœstrus purpureus* (Brauer) is reported for the first time from India. Five third stage larvæ of this species were found in the left frontal sinus of a donkey, which had lived all its life in Lahore and its suburbs. Mucous lining of the affected sinus was found to be intensely congested and inflamed.

Known geographical distribution of the fly has been given in the paper and a description of the third stage larva (the most commonly encountered parasitic stage) has been quoted from Fiebiger (*Tierischen Parasiten der Haus- und Nutz-tiere.* Wien, 1912). Pathogenicity of this species for equines as well as human beings has been discussed.

58(*a*). Rinderpest in sheep and goats in the Province of Bombay.

R. N. Naik, Bombay.

An extensive outbreak of rinderpest in sheep and goats has been reported for the first time from the Province of Bombay. The disease was brought under control by resorting to anti-rinderpest serum inoculations, which were carried out every ninth day. The dose of serum administered was 15 c.c. per animal by subcutaneous route.

Section IX, Agriculture.

17(*a*). A note on the relative efficiency of water requirements in relation to manurial treatments.

K. L. Khanna *and* P. C. Raheja, Pusa.

(*Sugarcane Research Scheme, Bihar.*)

Two sets of experiments were conducted in specially devised auto-irrigators for water requirements with a view to determine the effectiveness of the different manurial schedules, time of their application, form in which nitrogen should be applied and to express this effectiveness in terms of relative efficiency of water requirements. The results that have been obtained are summarized below:

(i) Complete manurial dose whether it was organic or inorganic schedule applied all at planting made the plants more economical in the use of water than the schedule where this manure was applied in two separate doses, i.e. half at planting and remaining half at earthing or where no manure was applied.

(ii) Application of Niciphos II was less economical from the point of view of water expenditure than an equivalent dose of castor cake.

(iii) Potash fertilization reduced the water expenditure per unit of dry matter produced.

(iv) Boron applications did not compare favourably with the standard schedule (40 lbs. N + 50 lbs. P_2O_5) though they were better than no manure (control) which was least economical from water expenditure point of view.

(v) Application of fertilizers in general gave statistically significant increase over no manure in the relative efficiency of water requirements.

23(*a*). Seasonal shoots in sugarcane.

K. L. KHANNA *and* R. R. PANJE, Pusa.

(*Sugarcane Research Scheme, Bihar.*)

A study on shoot-production in cane with a view to finding out the course of formation of shoots in the cane-season, the extent of the contributions to the final crop made by shoots produced at different periods, the characters of these different classes of shoots and their chances of survival was undertaken at Patna on Co 331, for the purpose of establishing the most economic plan of growth-regulation. By a system of tagging new shoots and recording deaths of old ones at certain intervals, the harvested crop was analysed and it was found that about 85% of the millable stalks, 91% of the tonnage and over 92% of the recoverable sugar were obtained from shoots produced during the hot weather; that the stalks of this class were not only superior to the rest in the millable length, individual stalk-weight, girth, number of joints per stalk, foliage at harvest and sucrose content and purity of juice, but were also characterised by lesser mortality. The successive classes up to the end of August showed generally a descending order of merit in all desirable characters. Those produced later failed to achieve cane-formation, and in their course of formation appeared to constitute a subsidiary tillering phase, apart from the grand period of the main tillering phase, the curve of tillering showing two peaks. The significance of the minor tillering phase is being investigated. The mortality curve also showed two peaks indicating the two consecutive life-cycles of the top-shoot borer to which almost all the deaths of shoots were due.

The study shows the importance of the main hot-weather tillering phase to the crop, as these tillers constitute by far the stablest, best and the most economic part of a cane-crop of Co 331 under normal local conditions.

Section X, Physiology.

6(*a*). Tissue culture—its application in Medical and biological researches.

N. N. DAS, Calcutta.

The application of Tissue culture in medical and biological researches has been thoroughly discussed.

31(*a*). Quality of cod liver oil in the Indian market.

N. K. IYENGER *and* B. MUKERJI, Calcutta.

Ninety-five samples of medicinal Cod Liver Oil, obtained directly from the open market in Calcutta as well as from the various provinces of British India through the courtesy of the Heads of Medical Departments, were subjected to analysis, and findings show that quite a fair proportion of the samples are definitely of poor quality, some of them not even containing certain active principles which may be responsible for the medicinal properties of the oil.

Out of 95 samples analyzed, 58(61·05%) specimens were found not to conform to the standards laid down in the B.P. 1932 and in the Addendum to the B.P. 1936. Forty nine (51·6%) samples gave a free fatty acid value in excess of the maximum limit, indicating that these oils were either old, rancid or prepared from partially decomposed livers. Twenty-three (24·2%) samples were deficient in vitamin A potency. Three samples (3·2%) were absolutely devoid of any vitamin A content. Sixteen samples (16·8%) failed to satisfy the requirements of the 'Chill Test', indicating the presence of steorin.

Section XI, Psychology.

56. New Psychology and its effect on creative literature.

A. CHAKRAVARTY, Lahore.

An attempt is made in this paper to study how certain major contributions of new Psychology are being assimilated in the domain of creative arts. It has emphasized above all else two important ideas, e.g., the idea of the sub-conscious and that of need of greater self-awareness on the part of man. The influence of the former idea on recent literature may be illustrated from the works of Hardy, O'Neill, Lawrence, Joyce, Auden, etc. This idea has also in addition thrown new light on the nature of the creative process itself, by which the literary artist produces his works. The influence of the second idea is reflected in new methods of writing biographies and autobiographies, and also in technique of individual and social characterization. It is not only prose literature, but also poetry, painting and music that have come under its influence.

The new Psychology has attempted to understand not only the individual, but also many social problems of great practical importance. Huxley's 'Ends and Means' may be cited as an instance of the literary expression of this attempt to analyze, and suggest remedies of social problems. Psychology seems to be helping literature in basing itself on the right aesthetic appeal on the line of sublimation process.

In spite of the interpenetration of Psychology and Literature, the functions of the two are distinct and separate. Literature does not seek to do the work of the clinic, nor does the Psychologist claim premium on æsthetic satisfaction.

57. Rhythm in modern Bengali.

AMALESH C. SEN *and* A. C. SEN, Calcutta.

Rhythm precedes language. Rhythm vs. accent in Bengali language. Time factor in Bengali rhythm. Abutting consonants and shifting of consonants. Recursives.

The history of changes in Phonemes. Growth of a new language is mainly a psychological matter to which the physiological setting is an adjustment and compares favourably with all organized activities.

58. Relation of thought and language.

D. L. Sharma, Udaipur.

An attempt is made here to understand the relation of thought and language from the study of differences of language structure in different races and from the analysis of mistakes made during speaking in a foreign language. The way in which language structure changes and vacillates during the expression of a thought in sentence throws also interesting light on this relation. Two possible theories on the subject are indicated—one along the psychoanalytic line of dream-interpretation, and another along the line of the Gestalt concept of mental stress ending in equilibrium.

59. Emotional growth in the education of a child.

U. S. Gheba, New Delhi.

The task of parents and teachers is to direct his instinctive energy into such channels as lead him to become physically fit, emotionally stable, and intellectually clear-headed for his self-realization and social service. But our educational system suffers from an intellectual bias and ignores the emotional development. Without training in the control of his emotions, a child remains unadjusted to his environments. As he grows older, he repeats the attitudes formed in early life and his old patterns of behaviour are reproduced.

60. Teacher and his make-up.

P. C. Lal, Kharar.

Modern education is said to be child-centred. But the teacher is no less important than the child. We have more power of selection of the teacher than of the child. An analysis of the teacher make-up may be useful. What is less often emphasized than his professional training is the teacher's integrated personality. Important factors of his personality are briefly discussed in this paper.

Proceedings of the Twenty-sixth Indian Science Congress

LAHORE SESSION, 1939

ERRATA AND ADDENDA

PART IV—DISCUSSION No. XV

The following should be added to the list of comments made at the discussion No. XV on Psychology in the Service of Education in India.

Prof. Muhammad Aslam, Lahore.

Prof. Aslam pointed out that Dr. Sengupta had failed to make the distinction between religious changes and social changes clear. We may try to understand the characteristic content of religious life by comparing greater religious changes with lesser ones, as e.g. comparing the origin of Christianity with that of Quakerism. It is true, as Dr. Sengupta points out, religion involves insight, but the particular form of insight that initiates true religious change is *verbal revelation.* If we are to understand the nature of religious change, we must 'understand this revelation along with the attitudes it evokes, and the sanctions and significance which it affords'.

Part IV, page 18—

Read—

'Prof. M. B. Pithawalla, Karachi, opened the discussion'

instead of—

'Mr. B. M. Pithawalla, Karachi, opened the discussion'.

Part IV, page 122, line 12 from bottom—

Read—

'Pithawalla, (Prof.) M. B., IV, 18'

instead of—

'Pithawalla, (Mr.) B. M., IV, 18'.

3. DISCUSSIONS

I. THE STRUCTURE OF LIQUIDS.

(Section of Mathematics and Physics.)

Dr. K. R. Ramanathan, Poona, presided.

1. Professor S. Bhagavantam, who was to have opened the discussion, communicated the following note for discussion:—

The following experimental facts obtained from investigations relating to the scattering of light and Raman effect in liquids are to be borne in mind in forming a picture of the liquid state:—

(1) The observed aggregate intensity of the scattered light does not agree with the results calculated on the basis of the existing theories.
(2) The distribution of intensity within the wings accompanying the Rayleigh lines is abnormal and has not yet been accounted for in a simple and convincing manner.
(3) The Rayleigh scattering consists of an undisplaced line and two displaced fine structure components. Their relative intensities vary with temperature and from liquid to liquid.
(4) An attempt to calculate the specific heats of liquids with the help of the known Raman frequencies results in values that are either too low or too high according as we treat the medium as a gas or as a solid.

These and other allied results suggest that molecules in the liquid are not as free to rotate as in a gas, that some kind of a temporary grouping amongst themselves has to be recognized, that their thermal movements may at least partly be replaced by elastic waves as in the case of solids and that the assumptions underlying the present theory of light scattering in dense media need to be revised.

In the absence of Professor Bhagavantam, the discussion was opened by Dr. Ramanathan. He referred to the various lines of work which in recent years had begun to throw light on the structure of liquids. Prominent among them are studies of the angular distribution of the intensity of X-rays scattered by liquids which gave a measure of the amount of disorder in the arrangement of molecules round any chosen molecule, the intensity and polarization of the light scattered by liquids and their variation with temperature, the discovery of the 'Krishnan Effect' showing the presence of multi-molecular aggregates in some liquids and studies of the Raman Effect in solids and liquids at different temperatures and in glasses.

2. Dr. I. Ramakrishna Rao, Waltair, spoke on the classification of liquids as associated and non-associated, the rôle of dipole moments and hydrogen-bonds on association, association of similar and dissimilar molecules and on Raman Effect as a suitable method for studying association in liquids.

3. Professor K. S. Krishnan, Calcutta, discussed how a study of the magnetic properties of solutions and their fluorescence was throwing light on questions of liquid structure. He gave a neat explanation of the magnetic birefringence of aqueous solutions of paramagnetic salts studied by Dr. Chinchalkar. Each paramagnetic ion is in the centre of an octahedron of water molecules which present their negatively charged oxygen ends towards the ion and its asymmetry is determined by the ion itself. The group as a whole, owing to the asymmetry of the electric field acting on the paramagnetic ion in the centre will be magnetically anisotropic and owing to the octahedron being non-regular, it will also be optically anisotropic and hence the double refraction.

4. Dr. L. A. Ramdas, Poona, spoke on the co-existence of liquid and vapour phases above the critical temperature. He referred to the measurements of light scattering in CO_2 at high pressure, carried out at Calcutta in 1926 and said that the intensity at a temperature near the critical point was different according as the temperature was approached from below or from above the critical temperature. He then discussed the recent measurements of O. Maass and his co-workers on the densities of liquids and their vapours near the critical point. Increase of pressure even above the critical temperature tends to establish structure.

5. Dr. H. R. Sarna, Hoshiarpur, gave an exposition of Debye's theory of dispersion of dielectric constants in liquids and discussed his recent measurements on the audiofrequency dispersion of dielectric constants in iso-amyl alcohol, benzene and their mixtures.

There was a general discussion following the reading of the papers.

II. THEORETICAL STATISTICS.

(Section of Mathematics and Physics, in co-operation with the Statistical Conference.)

PROF. S. N. BOSE, Dacca, presided.

1. PROF. P. C. MAHALANOBIS, Calcutta, opened the discussion:

The Technique of Random Sample Survey.

The technique of random sample survey was discussed with special reference to surveys on a geographical or regional basis such as crop census, crop-cutting experiments, forest surveys, etc., and his remarks were illustrated with results obtained during two experimental crop census conducted in Bengal in 1937 and 1938. The problem may be conveniently considered under the following heads:—

(1) Partitioning the whole area into suitable zones.

(2) Determination of the 'best' size of the sampling unit.
(3) Fixing the total number and density of sampling units per unit area (acre or square-mile, etc.); and their allocation to different zones.
(4) Procedure for selecting the sampling units at random.

The 'best' size and number may be conveniently defined as that set of values which, for any assigned total expenditure, would supply a final estimate with the lowest sampling error.

On the side of organization the chief factors are:—

(1) Cost of preparation of sampling units and analysis of results.
(2) Cost of collecting the field information.
(3) In the case of a semi-permanent or permanent organization the question of the most efficient distribution of labour.

It is well known that the efficiency of the sampling can be increased by dividing the whole area into a number of homogeneous zones; but the accuracy with which this can be done depends entirely on the previous knowledge available. In actual practice this problem can be solved only on a trial and success basis.

Questions of some theoretical interest are, however, involved in fixing the 'best' size of the sampling unit, the total number, and the number of units to be allotted to each zone. The total number will, of course, ultimately depend on (*a*) the accuracy which it is desired to attain in the final estimate, (*b*) the area in the different zones, and (*c*) the variability from one spot to another of the area within each zone.

Questions of cost are also involved in fixing the 'best' size and the 'best' number of sampling units or grids. A convenient approach to the theoretical solution of the problem is given by constructing two separate functions:—(*a*) the 'variance' function giving the sampling variance for different sizes of the sampling unit; and (*b*) the 'cost' function giving the total cost involved in collecting, say, 100 sampling units of various sizes. The variance function is determined by the manner in which the elements under survey are actually distributed in space. The cost function is made up of three different kinds of elements: (*a*) cost of statistical portion of the work, (*b*) cost of field enumeration, (*c*) overhead and other expenses. The cost of field work per sampling unit is determined by the time taken for the actual field inspection and enumeration (which will depend on the size of the sampling unit) plus the time taken to move from one unit to another.

If the results of a complete enumeration happen to be available, it is possible to study the 'variance function' by model sampling experiments in the Laboratory. The cost function, however, can only be studied by actual experiments on the field.

Once the variance function and the cost functions have been suitably formulated, it is possible to obtain the best size and number of sampling units by straightforward analytic methods which are illustrated with the help of actual numerical figures obtained during two recent experimental crop surveys in Bengal.

In the case of jute crop in Bengal, which was scattered over 70 lakhs of individual plots out of 11 or 12 crores of plots covering an area of 55,000 sq. miles, the cost of a complete enumeration had been estimated at anything between 12 or 15 and 20 or 25 lakhs of rupees. In a random sample survey, on the other hand, it should be possible to obtain a provincial estimate with an accuracy of the order of three or four per cent. at a cost of about two lakhs of rupees.

It was followed by a brisk discussion relating to the theoretical problems in which a large number of persons including Professors S. N. Bose (Dacca), N. R. Sen (Calcutta), K. Krishnan (Calcutta), K. B. Madhava (Mysore), Dr. K. R. Ramanathan (Poona), and others participated.

2. Mr. S. N. Roy, Calcutta:

Discussed one special problem which had arisen in the same connexion. He showed that the exact distribution of a mean of a number of correlated variates (each pair of which had the same intra-class correlation) was given by the usual Gauss-Laplacian formula.

3. Prof. K. B. Madhava, Mysore:

Discussed the broader aspects of the sampling technique in random surveys, and stressed the importance of proper stratification and the use of necessary 'control'.

Other subjects.

1. Messrs. R. C. Bose *and* S. N. Roy, Calcutta.

The distribution of Studentized D^2-statistic appropriate to any pair out of a given set of k equidispersional population distinct in sets of means.

2. Mr. R. C. Bose, Calcutta.

The application of the theory of Galois fields and associated finite projective geometries to the construction of completely orthogonalized hyper-Graeco-Latin Squares.

3. Messrs. R. C. Bose *and* K. Kishen, Calcutta.

The application of the theory of Galois fields and associated finite projective geometries to investigate the generalized interaction in a s^n factorial arrangement, where s is a prime or a power of a prime.

III. RÔLE OF THE MODERN GEOGRAPHER IN INDIA.

(Section of Geography and Geodesy.)

Mr. N. Subrahmanyam, Saidapet, presided and opened the discussion.

Opening Remarks.

The science of Geography, being synthetical, is *the* one subject of school and college studies, which makes a man take living interest in his environment *as a whole,* so that he may intelligently relate himself to his village and town and city; to India, the empire and the world at large.

Geography, besides unifying and vivifying one's knowledge, helps a man to make that knowledge creative as well as recreative and play his part with better appreciation.

Modern Geography in its dynamic aspect emphasizes the several processes at work and bids every man, though indirectly, to do his bit in them, expanding his horizon, unlike the old static Geography which was mainly descriptive.

How best outlook may be geographized so as to meet demands of modernity is the subject proposed for discussion.

2. Dr. S. P. Chatterjee, Calcutta.

He pointed out that the aim and method of geography should be clearly understood, and claimed that geographical researches if conducted under proper guidance could do a lot in solving various economic problems with which we are faced to-day. 'Take for instance, Bengal,' said Dr. Chatterjee, 'where lands are deteriorating, soils fast losing their power of productivity, rivers failing to fulfil their task of land building, marshes and swamps increasing in area at the cost of good arable lands and a large number of population subsisting on a semi-starved diet in a pitiable environment. Other provinces are no better, though their problems may be slightly different.' For a proper solution of these Dr. Chatterjee remarked that 'a stock-taking on a provincial basis is needed in the first instance, that is to say a geographic survey is to be conducted with a view to showing the economic and agricultural possibilities of the provinces, and furnishing materials on which an edifice of future prosperous India could be built up.' Dr. Chatterjeė further remarked that 'in an industrial country like England where the peasantry as a class does not exist, and only 7% of the working population are engaged in agriculture as compared to 80% in Bengal, the Land utilization survey has been functioning for the last eight years under the direction of an eminent geographer, Dr. L. Dudley Stamp, with a view to recording the existing use of every acre of land in Great Britain. The work when completed will serve as a standard of comparison with the past, a contribution to the study of current problems, and a basis of planning for the future. In the U.S.A. as many as 47 State planning Boards are functioning under the direction of American geographers. They are examining the physical resources of the State—land, water, minerals, problems of better management of their forests, provision of better recreational facilities, the best use of agricultural lands, the type of people who live there, their problems of subsistence, income, health, in brief, how they live'. In view of the importance of such survey work conducted abroad by geographers for national causes Dr. Chatterjee said that preliminary work for the geographical survey of Bengal has already been started by members of the staff of the Geography Department of Calcutta University, under the patronage of Dr. Syamaprasad Mookerjee, Former Vice-Chancellor of the Calcutta University.

3. DR. A. F. GEDDES, Edinburgh.

He was very much interested with the survey work mentioned by Dr. S. P. Chatterjee and pointed out that geographers alone could do this sort of work. He remarked that land settlement maps should be utilized for this purpose.

4. MR. M. SUBRAHMANIAM, Madras.

In South India, settlements have been thoroughgoing, impartial, made by fully competent, full-timed, and well-paid officers after a complete survey of soil and area. Geography has all materials ready to hand, and to build up a synthesis of what has been studied in parts is the geographer's function.

5. MR. A. K. BANERJEE, Calcutta.

The modern geographer is to undertake the duty of explaining the problems of life in all its various aspects. His is the key subject which explains the fundamentals of other subjects. A geographer should rise above narrow provincialism and explain everything in a wider and broader way. To a geographer political boundaries are no limits of land: his domain is wider than what can be found in the map of an aggressive tyrant. He would explain a region with sympathy with the people, he will preach his philosophy to unify the dwellers of earth and not to separate them.

From the practical aspect a geographer's duty is to preach his philosophy in an easier and more palatable way to the youngsters as well as to the mass. A book of geography may be quite unintelligible to an illiterate man but he can be educated with the help of maps where there are lines and colours.

IV. A NEED FOR UNIFORMITY IN THE PHYSIOGRAPHIC DIVISIONS OF INDIA.

(Sections of Geography and Geodesy, Geology, Mathematics and Physics (for Meteorologists), Botany and Zoology.)

Mr. N. Subrahmanyam, Saidapet, presided.

1. Mr. B. M. Pithawalla, Karachi, opened the discussion.

Opening Remarks.

The present political divisions of India are due to historical accidents and administrative conveniences. They do not furnish a basis for scientific studies and surveys and records, as in Geology, Botany, etc. A division into natural sub-regions affords it and the principles to draw them up are to be settled.

Now that Indian geographers have begun taking interest in the regional geography of India, I think it is absolutely necessary that our work should be co-ordinated in regard to the physiographic divisions at least. I have already adopted, with suitable modifications, the method of physiographic division, employed by the Association of American Geographers, for my pioneer regional study of the Lower Indus Basin (Sind) (*Proc. Ind. Aca. Sci.* B, Vol. IV, No. 4) and as I have found it quite suitable for our country, I am advocating it as one, which other workers in the field. may utilize with advantage, in order to avoid any overlapping or confusion of boundaries etc. There must be uniformity and homogeneity in the divisions of our country at any rate.

Such physiographic divisions, uniformly made, would be of immense scientific value, as a most reliable background for other surveys, such as those of agriculture, industry, economics, water-supply, population, etc. They will be in fact in great demand from Government, Municipalities, Corporations and other departments.

I realize the difficulties of producing a satisfactory division of India into physiographic regions, e.g. political or administrative boundaries, naming of divisions, study of land-forms and departmental reports or blue books, but they can be solved if an All-India Geographical Association is established.

The so-called natural divisions of India made by previous workers in the field, should now be superseded by physiographic regions, approved by such a responsible body, as I have suggested.

Applying the principle of structure, process of erosion and present state of land-forms, affected by subaerial agencies, I have prepared a map of India and Burma, showing:—

3 Major Divisions.	17 Provinces.
(1) Extra-Peninsular Mountains	I. Western Highlands
	II. Greater Himalayas
	III. Middle Himalayas
	IV. Sub-Himalayan Region
	V. Eastern Highlands
(2) Indo-Gangetic Plain	I. Lower Indus Valley
	II. Upper Indus Valley
	III. The Desert Province
	IV. Upper Ganges Valley
	V. Middle Ganges Valley
	VI. Lower Ganges Valley

3) Peninsular India

I. Rajputana Uplands
II. Deccan Trap Region
III. North-Eastern Table-land
IV. Southern Plateau
V. Western Coast Province
VI. Eastern Coast Province

The resultant of various other forces will be considered and everything will be taken into account, when fixing details about the minor divisions.

Mr. B. M. Thirunaranan objected to drawing boundary lines of the regions proposed by Mr. B. M. Pithawalla without doing any detailed field work. He then pointed out that the divisions as proposed of South India were arbitrary and did not conform to the existing geographical conditions of the area.

Professor Agharkar vehemently criticised the method adopted by Mr. Pithawalla in dividing India into its natural regions and said that botanists have their own classification and geographers without the help of botanists could not solve the problem satisfactorily.

Dr. S. P. Chatterjee agreed with Prof. Agharkar and recalled the method adopted by Dr. Unstead in drawing the natural boundary lines of Astrakan area in which one of the boundary lines was drawn on the basis of vegetation, another on the basis of the physiographic features, another on the basis of climate and so on. Even if we do not take into account any of the factors except physiographical, we must be thoroughly acquainted with all the types of topography such as Karst topography, Appalacian mountain type, etc. But the proposed divisions have not taken into account any of the topographical features and consequently have no scientific value.

V. THE AGRICULTURAL CYCLE.

(Sections of Geography and Geodesy, Agriculture, Botany, Mathematics and Physics (for Meteorologists) and Zoology (for Entomologists).)

Mr. N. Subrahmanyam, Saidapet, presided and opened the discussion.

Opening Remarks.

Agriculture remains the chief occupation of India. Closely connected as it is with the Cycle of Seasons with all the variations thereof that each locality presents, it is sensitive in a high degree to almost every factor associated with it. Such factors have their own cycles and rhythms, particularly in this monsoonic country, where all the elements of climate, wind and rain and sun, are regular in normal years. The rise and fall of the water-table, water inadequacy in winter, drought of abnormal years, relationship to waste and forest, the incidence of insect-pests, life-cycles of each agri-horti-plant from seed to corn and fruit, animal husbandry, the seasonal acitivity, movement, rest and amusements of farmer and labourer, along with their subsidiary and collateral occupations, etc.—all such act and react upon agriculture. The compounded cycle of them all go to make the full agricultural cycle.

Great work has been done by the several scientific departments each in its own sphere; and it is necessary to integrate the several data obtained and co-ordinate them from time to time.

Geography as synthetic science steps in to gather up the *results* obtained by each separately, to put them into appropriate maps, plans and diagrams, and correlate them all.

That can best be done with the complete co-operation of all concerned, only after a full discussion settling lines of work.

Accordingly, a joint discussion is proposed in which the several Sections concerned will participate, with fruitful results.

2. DR. T. V. R. AYYAR, Coimbatore.

As an Entomologist I would like to point out that in the case of insect-pests of different kinds affecting different crops a sort of calendar or life-cycle could be prepared as one of the main branches of the main cycle of agriculture. I have prepared diagrams of insect calendars of this kind to illustrate my presidential address in the agricultural Section of this Congress.

VI. ZOOGEOGRAPHY OF INDIA.

(*Section of Zoology.*)

PROF. C. R. NARAYAN RAO, Bangalore, presided.

1. DR. BAINI PRASHAD, Calcutta, opened the discussion.

Opening Remarks.

Zoogeography is a scientific study of the distribution of animal life all over the earth and of the mutual influences of animals and the varied environments, one on the other. Within recent years zoogeographical work has, however, been carried out along several distinct lines such as Faunal Geography, Comparative Zoogeography, Palæozoogeography, Ecological Zoogeography, etc., and although great advances have been made along all these lines, our information in regard to the zoogeography of India (*sensu stricto*) is still limited. Earlier Zoogeographers like Wallace, Huxley, Sclater, Sharp, Heilprin and others mainly considered the present-day distribution of animals, and on the basis of the data thus obtained attempted to divide the earth's surface into a number of zoogeographical regions or realms. Though the data in regard to all classes of animals were taken into consideration the divisions were based mainly on the distribution of mammals and birds, but even so no uniform scheme was found possible. The regions were further sub-divided into sub-regions or provinces.

After these preliminary remarks, the zoogeography of India in general was considered. Having defined the limits of the area, the author remarked that this area falls mainly within the Oriental Region of Wallace or the Indo-Malay of Elwes, but the Western Frontier territory, the greater part of the Punjab and the Western Himalayan area to the western limit of Nepal with Gilgit and Ladak have, in view of the predominance of palæarctic forms, to be included in the Holarctic or the Palæarctic Region. The Indo-Gangetic Plain also shows certain definite affinities with the Western Frontier territory. The division of this vast area into sub-regions, according to different authors, was considered in detail and the division of the Indo-Malayan area of India into the Cisgangetic and the Transgangetic sub-regions, as advocated by Blandford, was accepted as the most satisfactory scheme. The boundaries and the main characteristics of the faunas of the different sub-regions were considered and reference was made to the peculiar admixture of faunas, particularly in the Cisgangetic region. The three constituents of this fauna are the Dravidian, the Aryan and the Indo-Malayan or Oriental. In the Peninsular region there is a great concentration of the Oriental element, but the occurrence of certain Burmese and Malayan forms, which are not represented in the intervening area, is remarkable. The Dravidian element is restricted to the Ghats and other outlying regions. Certain Himalayan species also occur in the mountainous tracts of Southern India and Burma and even further south, but not in the intervening areas. Reference was also made of the Aethiopian element and the various views which have been advanced to explain its occurrence in the fauna of Peninsular India.

The importance of palæogeological factors in regard to the origin of the mammalian fauna of India was discussed and a passing mention was made of the occurrence of identical aquatic species in the Indus and the Ganges river system which, in view of the limited means of dispersal of such forms, necessitates the postulation of a continuous river—the Indo-brahm or Siwalik River in place of the Indus and Gangetic River-systems of the present times.

Finally it was remarked that our information in regard to the fauna of India is still far from complete, and a great deal of intensive collection of the fauna of different areas is essential before a true picture of the composition and relationships of the fauna of this vast continental shelf would become available.

2. **Prof. C. R. Narayan Rao**, Bangalore.

The subject of Zoogeography important as it is as an integral part of Zoology can be built up only by a diligent co-operation of the field workers and systematists. The several phases, especially ecological aspect, and distribution should be carefully noted. In this respect the Universities could render invaluable assistance by enlisting the active co-operation of students in making collections in their localities. Dr. Baini Prashad's brilliant paper deserves to be taken up at the next session of the Congress and delegates would have an opportunity to study the problems in the meantime, and if they could bring with them notes made by themselves and their students a great forward step may be taken in the preparation of a well-planned and comprehensive scheme of study.

VII. SCOPE OF PRIVATE ENTERPRISE IN ARCHÆOLOGICAL AND ANTHROPOLOGICAL RESEARCH IN INDIA.

(Section of Anthropology.)

Dr. D. N. Majumdar, Lucknow, presided.

1. **Dr. C. L. Fabri**, Lahore.

After a brief survey of the history of archæology in this country, Dr. Fabri went on to say that India was, in his knowledge, the only country where archæology was entirely in the hands of a Government Department. He quoted the example of Egypt, Iran, Iraq, China, Greece, Italy, where all the important excavations were always done by learned bodies or individuals, supported from private donations, and not by the Governments concerned. Although the work of the Archæological Survey of India was truly wonderful, the time has now come to realize that a change in the general policy and system was necessary. The officers were over-worked (fifteen officers were 'axed' in 1931), the grants miserable, there was no chance for important research work being carried out by the Survey. The lecturer was full of praise for the hard struggle which the officers of the Survey fight, most of their time being taken up by administrative work and conservation. 'For research work,' he said, 'we must look to private enterprise. It is a fact that according to the new constitution, archæology is a "reserved subject"; but nothing prevents the provinces from establishing private excavation and research Funds, such as the Punjab Exploration Fund, and carrying out fine work with the aid of private support, and, perhaps, some support from the local governments. The Archæological Survey would, in this new system, have the rôle of a centralizing, supervising institution, granting licences to approved and well-equipped societies only, and seeing that the latest methods of scientific work are used only. This is what happens in most countries, like Egypt, Iran, China, Iraq, where the Government department carries out yearly one excavation only, but supervises the work of a large number of non-governmental bodies. But then the attitude of the Department has to change. Instead of granting licences with great reluctance, the Survey should go quite out of their way to come and help these young provincial societies, with advice and otherwise; for their work is finally for the benefit of Indian archæology. Particularly in the beginning, Delhi should hail with great pleasure the establishment of provincial Exploration Funds.' He emphasized that he had no complaint, for he has received sympathetic treatment from the Department, and the work of the Punjab Exploration Fund was going on steadily. But what he visualized was a more energetic, forward policy which would be all to the benefit of antiquarian research in this country.

'One advantage of private funds would be the necessity of informing the larger public about our work. The Government officers, who are anyhow overworked, cannot spend their time in lecturing to the larger public; but officers of a private Exploration Fund have to make periodical reports to their donors, and thus to keep the enthusiasm of the public alive, ensure that a next generation of archæologists shall be brought up; and, finally, by propagating the subject, to recruit more people who are interested in research. These people are, after all, the people who vote in the assemblies of the nation; and if they have no interest in antiquarian and anthropological research, they will refuse grants in the assemblies.'

In the discussion that followed the members all agreed about the importance of educating the larger public; there was a unanimous agreement that the Central Government cannot be expected to carry out single-handed large-scale research work, and that the establishment of provincial Exploration Funds is the only hope of archæological and anthropological research in India.

2. PROF. K. P. CHATTOPADHYAY, Calcutta.

The Speaker pointed out the work done in Bengal by the Varendra Research Society and the Royal Asiatic Society of Bengal. The departments of Ancient Indian History and of Anthropology of the Calcutta University, he pointed out, had also taken up the question of archæological and anthropological explorations. It was a matter of regret that endowments had not come forward for such work. He agreed with the mover about the necessity of private enterprise in this direction.

Dr. D. N. Majumdar, Lucknow (President), thanked the leader of the discussion and congratulated him particularly on the fine beginning made with the Punjab Exploration Fund. He agreed with Dr. Fabri on most of the points, and remarked that if the plight of archæology was bad, that of anthropology was even worse. Without proper organization, as suggested by the leader of the discussion, nothing could be done; and he was also convinced that the right way in this direction was to give more popular lectures to the larger public. This is a point which they must think out properly, and the sooner action was taken on these lines, the better the chances of building up provincial societies for anthropological and archæological research.

On Dr. Majumdar's suggestion it was resolved to constitute a Committee to draw up a plan in this direction which should be presented at the next Session of the Congress at Madras, with Dr. Fabri as Secretary.

VIII. APPLICATION OF STATISTICAL METHODS IN ANTHROPOLOGICAL RESEARCH.

(Section of Anthropology, in co-operation with the Statistical Conference.)

DR. D. N. MAJUMDAR, Lucknow, presided.

1. PROF. P. C. MAHALANOBIS, Calcutta.

Opening Remarks.

'Application of Statistical Methods to Anthropometry.'

The problem is considered under three heads:—

(1) Standardization of measurements.
(2) A standard list of measurements.
(3) A standard statistical method for comparative studies.

(1) As regards the standardization of measurements especially on living subjects, the first thing necessary is a careful study of personal equations of different observers for different measurements to find out which measurements can be taken with greatest reliability. It is suggested that a controlled experiment on a co-operative basis should be undertaken at an early date for this purpose.

(2) In preparing a standard list of measurements, it is necessary that the measurements should be such as are capable of being measured with reliability by different observers, and secondly, should be such as to furnish the maximum information regarding the racial or group differences, and thirdly, should be statistically as independent as possible. It may not be possible to use one standard list for the whole world or even for the whole of India. It may be desirable, in fact, to have a short basic list which will be supplemented by additional measurements for particular regions or for special studies. Attempts should be made to prepare such lists for India.

(3) As regards the statistical technique it is suggested that intercorrelations between characters should be taken into consideration. Appropriate methods for this purpose have been developed in the form of a generalized distance by the author, and directional vectors recently defined by Prof. R. A. Fisher. It is necessary, however, that the number of characters should be reduced as much as possible in order to make it possible to use this method in practice.

Prof. K. P. Chattopadhyay of Calcutta and Dr. D. N. Majumdar took part in the discussion and it was agreed upon that the President, Dr. Majumdar, would approach the physical anthropologists in India for co-operation and later on a small committee might be set up to consider the above problem in detail and to report on the subject at the next session of Indian Science Congress.

IX. SOCIAL DISORGANIZATION.

(Sections of Anthropology and Psychology.)

DR. D. N. MAJUMDAR, Lucknow, presided.

1. DR. N. N. SEN GUPTA, Lucknow.

Opening Remarks.

Society is a configuration of several constituents. When the inter-relation between these is such that each responds to a change in the other, we have what we may call a *Sensitive Society.* Small groups, rural social life, a selected community such as religious group or a university group are sensitive groups of this type.

When the various societal constituents are less responsive to the change in one another, we call it a *Distributed Society.* An urban community, a large group such as a state, federal types of organizations, are instances of this. A group, such as a family, which serves several functions in the Social Scheme, is a *Poly-functional Group.*

The former type, the sensitive society, disintegrates with the disruption of *Poly-functional groups* and the scheme of the group-objects. The other societal constituents bring about social disorganization by disorganizing the nuclei of the social configuration. The Distributed group is less liable to disorganization inasmuch as the different factors vary more or less independently. The phenomena of social disorganization, therefore, depends upon: (1) *the focus crisis sets* in, (2) *upon an amount of change*, and, above all, upon the (3) *type of the social configuration.*

2. MR. N. S. N. SASTRY, Mysore.

Rôle of Individual in Social Disorganization.

I. Society is composed of individuals. The instinctive trends that govern individual behaviour are modified in society, and thereby social responsibility is imposed.

II. Social maladjustment of the individual has its causes in the psychological limitations of the individual's nature. Environment and Education have to facilitate the growth of social bias. Sublimation must be helped by socially approved customs, religious observances, morality, etc. But in a changing world there is sometimes social hindrance.

III. Social unrest, first noticed in the individuals, is brought about by individual maladjustment caused by: (1) group ideology being inadequate, (2) group propensities being opposed to group ideology, and (3) cumulative effect of individual unrest.

IV. Social unrest, from the psycho-analytic standpoint, might be due to: (1) Œdipus Complex and transfer, (2) Inferiority Complex and the other Ego Complexes, and (3) to unconscious fear.

V. Individual's adjustment for the purpose of social integration is necessary and possible. The environment and education must be moulded on a proper consideration of ultimate values. Scope for the discharge of emotional excesses and pent up craving must be provided for. Social solidarity must be based not upon the psychological exploitation of the individual but upon coherence of personalities.

3. MR. PARS RAM, Lahore.

Social disorganization must be understood in the light of Psychology. Granted that non-psychological forces such as the shortage of food, changes in the density of population and changes in the composition of the ruling class, etc. do cause the degeneration of the social institutions, but these causes become dynamic only when they produce tensions in the individual. It is in these tensions that we should look for the minute details of the social change. Without Psychology the details of the pattern of social disorganization remain obscure and hidden. But what kind of psychology can help us in interpreting social phenomena? The writers on social affairs usually conceive of man as pursuing a hypothetical goal—the satisfaction of certain instincts. Such writers take a naive and crude view of human nature which cannot take us very far in predicting and manipulating social phenomena. Nor can laboratory psychology help us very much in this because it deals with the individual in a very limited field. What is needed is a social psychology historically differentiated; which can make known to us the changes in human motivation and attitudes in different periods of history, in different classes and under different social conditions. In other words psychology itself must be socialized in order that it may be applied to social sciences. Such a social psychology is beginning to emerge from the account of human nature given by anthropologists, sociologists and psycho-analysists. The field-dynamic theory of Curt Lewin has supplied the logical concepts for this psychology.

Social institutions—taboos—marriage, family, etc. can be described in terms of field-dynamic psychology as devices for maintaining optimal tension and equilibrium between the impulses of the individual. Hence social organization absorbs much of the libido of the individual. In social disorganization the barrier between the individual and the social institutions, becomes so great that the tensions from the one do not discharge themselves into the other. Hence social disorganization brings much stress and storm for the individual. This leads to the worship of symbols. Communism and socialism and other forms of 'isms appear to the people as means of their salvation. New religious movement is the characteristic of the people whose social institutions have degenerated. The symbol may become the nucleus of new enthusiasm. And in this stage of restlessness a leader of the people—the symbol of the mental suffering of the people—may emerge. But this leader is usually himself emotionally unstable and is a calculating type who knows how to manipulate the emotions of the people. This stage cannot last longer as ultimately people begin to compare the semi-hypnotic state of their minds in worshipping symbols with that of the normal state.

4. Mr. K. C. Mukherji, Dacca.

Social disorganization is opposed to social cohesion, the most elementary example of which is the organization and behaviour of the ordinary family. The perfection of social cohesion depends largely on the spontaneity of social feeling. The spontaneous feeling may occur instinctively or rationally by social self-consciousness. Where spontaneous feeling fails social integrity is maintained by such makeshifts as bribery, patronage, coercion, etc. But in case of any stress or strain the integrity breaks up and disorganization ensues.

Disharmonious relation is an important, but not the only factor of social disorganization. Its influence is especially manifested in the disorganization of demotic society. But in ethnical disorganization geographical conditions and environmental factors including customs, usages, etc. are important. Besides, individuals may become sociologically unfit and cause social disorganization. The phenomena of social disorganization are not fundamentally different from the phenomena of organic disintegration. The disorganization originates in some kind of conflict or coercion which ultimately obscures the distinction of the primary and the secondary causes of the issues involved.

The disorganization of a society is often compared to the crumbling of a wall or the falling to pieces of a structure that once was strong. In disorganized society the feeling for the whole is lost greatly; the I-feeling tends to gain on the we-feeling.

The occurrence of social disorganization is not fundamentally different from the occurrence of organic disintegration.

The external and internal factors which adversely affect social cohesion are as follows:—

(1) A change of climate for the worse.
(2) Soil-exhaustion, want of food-supply.
(3) Subjugation.
(4) Mechanism.
(5) War.
(6) The dwindling or disappearance of the middle class.
(7) Predominance of the parasitic unfit and the reduction of the gifted stock.
(8) Some social customs as anti-social.

5. MR. H. P. MAITI, Calcutta.

Social disorganization is as much a natural phenomenon as social organization. They constitute the two poles of the process of normal social change. Social science has to enquire into the conditions and principles of both of them. It can take, however, for special consideration the pathological forms of social disorganization in view of the greatly harmful effects these are usually found to have. But, in the opinion of the speaker, not much useful purpose will be served by investigation and discussion in this practically important line of sociology if we cannot begin with a proper definition of a 'pathological degree' of social disorganization. We should try, in other words, to formulate some criteria of normal or abnormal disorganization. Inasmuch as social organization necessarily implies individuals whom it unites, the sciences of sociology and psychology have to be equally interested in this question. The disorganization process has two active foci, one in the customs and institutions and the other in the individual's beliefs, feelings and habits.

The President, Dr. D. N. Majumdar, summed up the debate and referred to social disorganization in progress among the many primitive tribes in India. He showed how contacts with civilization brought about by diverse methods have resulted in important demographic consequences. The stringent forest laws in many areas have released these tribes from their traditional occupations but have not provided any useful occupation to assist them in their attempts at adaptation. The disparity in the proportion of sexes, imported diseases, loss of ambition in life and similar factors were leading to depopulation in their ranks. Dr. Majumdar added that the functional attitude in anthropology has helped anthropologists in evaluating the importance of culture contacts. To-day anthropologists' approach to the study of culture was not only diagnostic but also therapeutic; so that application of anthropological methods to practical problems of life was possible. This is why there were to-day, he said, standing committees on applied anthropology in various parts of the world, where clash and fusion of cultures were in progress. Finally he appealed to the psychologists not to remain content with data collected by anthropologists from primitive and backward societies but also to actively co-operate with them in field investigations which would certainly help in assessing the gravity of the process of mal-adaptation in different types of societies.

X. DISEASE AND PEST RESISTANCE IN CROPS.

(Sections of Agriculture, Botany, Zoology, in co-operation with the Society of Biological Chemists, India.)

DR. T. V. R. AYYAR, Coimbatore, President, Section of Agriculture, presided.

The President made some general remarks in introducing the subject particularly from the point of view of an entomologist. The following gentlemen then took part in the discussion.

1. DR. H. S. PRUTHI, New Delhi.

Most of the wild plants are not destroyed by insects in the same way as the cultivated crops. The problem of discovering and breeding resistant varieties is very important because one of the cheapest methods of fighting insect pests is to grow resistant varieties. However, the problem is not so simple. The behaviour of crop varieties in reference to insect attack, as in several other respects, is very much dependent upon environmental conditions. A variety resistant in one province may not prove to be so in another province. Moreover, the anti-pest resistance is often relative—that is, a variety is resistant as long as a susceptible variety is available in the neighbourhood. Insects are capable of changing their food plants very readily. In the absence of a 'susceptible' crop the 'resistant' one gets attacked. But this comparative resistance is useful as it gives time to the worker to breed new resistant varieties. Thus the work is more or less continuous. So far very few varieties are known which have proved to be permanently or absolutely immune to pest attack.

As regards the factors which confer resistance, they differ in the case of various pests.

2. MR. B. VISWA NATH, New Delhi.

Resistance of plants to pest and disease damage can be inherited or acquired. Specific morphological features of plants play an important rôle in the resistance offered by plants to disease and insect attack. Resistance in certain plants may be due to certain substances antagonistic to or incompatible with the needs and habits of the invading organism.

The trend of recent research into the chemistry of the nutrition of plants having shown that plants like animals require certain nutritional factors for their healthy growth and development, the state of nutrition may also be a factor in determining the state of health of the plant and its resistance or otherwise to disease or insect attack.

Water as a vehicle for the conveyance of nutrients are conveyed from the soil, to and through the plant, the state of excess or deficit over the optimum balance necessary in the soil can bring about in the plant deficient absorption, disturbed water balance, leading to diminished photosynthetic activity, unfavourable acid-base balance in plant, all of which, singly or together, bring about susceptibility to disease.

3. MR. P. N. KRISHNA AYYAR, Coimbatore.

Food as a factor in plant resistance to insect pests.

In any insect control project, the question of plant resistance is of no mean importance. The practical value of this phenomenon is increasingly recognized and sought to be utilized. An investigation into the control of the cotton stem weevil of South India (*Pempheres affinis*) has served to bring the general question of resistance, tolerance or susceptibility to great prominence. Resistance is admittedly a complex phenomenon and diverse are the factors that have been brought to light to elucidate the same. Not infrequently, a variety of factors, physical, chemical or physiological in combination, influence the results. It may be seen that much of the work on this aspect has been centred round sap-feeding insects like Aphids, Froghoppers, Capsids, Thrips, etc. Dipterous Larvæ, Caterpillars and even Beetles have also attracted some attention. Many of these have been exhaustively dealt with in several scattered papers by various authors. Of late, these have been summarized also in a few recent text-books. These notwithstanding, little is known regarding the fundamental causes of such phenomena. The subject very naturally falls into three or four main groups or categories. Some are in the main ecological, resulting in a transitory evasion of an insect; others are due to some external protective agencies; still others are traced to internal causes due to the presence or absence of certain chemical substances; the last class which is also internal, is based on the food factor of insects. It is the purpose of this short note to emphasize the importance of the last factor. Incidentally a brief review of the other aspects is also attempted.

Factors producing a transitory avoidance.

Entomologists are familiar with the fact that resistance is mainly a question of reduced susceptibility. The vigour and condition of a plant is an important factor. And this is governed by such characters as soil aeration, manurial treatment, climate influences, power of recuperation, etc. Among these a shortage or increase of water supply by rainfall or irrigation exercises great influence. Water is an all-important factor. An insufficient water supply increases susceptibility of cotton or sugarcane to sap-feeding insects (Mumford, 1931; Holroyde Hey, 1930; Davidson, 1923). Water relations affect availability of plant food materials since water forms the vehicle for carrying the same in solution by roots (Withycombe, 1926). In the case of Pempheres, irrigated cottons are seen to be more susceptible to its attack. A judicious use of fertilizers increases resistance. Increased resistance of wheat to Hessain fly by enhancing the ash content or silica content has been noted (McColloch, 1924). An increase in ratio of potash to phosphoric acid in tea leaves diminishes its susceptibility to Helopeltis (Andrews, 1923). Silica content and crude fibre production protects oats from Fritfly (Cunliffe, 1936). Cotton plants treated with solenium inhibit Aphis breeding and cause Adult mortality. Such Solenized plants caused Pink boht worm mortality, in bolls (Mason and Phillis, 1938). Adoption of seasonal variations by altering date of sowing or maturity causes evasion. Early hardening of Tephrosia seeds in Java makes them immune from the attack of a Platysomid beetle ovipositing on seeds. Late sowing of cotton reduce Pempheres incidence in South India. Varietal differences also have some influence. In a general way, indigenous country cottons under dry cultivation, are, to a slight extent, less susceptible to this weevil in South India. As in the case of cotton boll weevil in Texas, high temperatures also exercise a check on Pempheres incidence.

External protective agencies.

The protection afforded by external morphological characters are less efficient than internal factors. A familiar protective factor for both animals and plants is the thickness or toughness of the integument. Animals with a tough skin are generally free from such ectoparasites as ticks, lice or flies. Hard husks of walnut fruits of certain varieties resist the attack of Rhagoletes despite its oviposition. Tough seed coats are also protective. Thick skinned citrus, grapes, apples and papayas suffer little from plant bugs and fruit flies. The development of selerenchyma or other mechanical tissues afford some protection against insects.

Resistance of certain apple varieties to wholly Aphis is in proportion to the percentage of selerenchyma in the circumference of the stem (Stainlund, 1924). Seeds of sunflower varieties in Russia resist certain pyralids by the formation of a carbohydrate layer between the corky tissue and the selerenchyma (Sakharoa, 1925).

Another factor is the general hairiness or its absence. Certain upland cottons in South Africa covered with dense hairs on stem, leaf and bracts, suffer less from Jassids (Worral, 1923, Parnell, 1925). A long tightly wrapped husk protects the cob from damage by corn ear-worm Hileothis (Phillips and Barber, 1931). Presence of tannin materials in the husk of cacao protects it against Ephestia (Molz).

Internal bio-chemical qualities rendering plants unattractive or repellant.

The presence or absence of alkaloids is a factor affording protection to Teak, Ironwood, ànd Peach against Termites (Hagen, 1855). The occurrence of essential oils in rind of citrus fruits reduces injury by fruit fly ceratitles (Back and Pomberton, 1915). Crucifers suffer from cabbage worm due to lack of Mustard oil. Acidity of cell sap (due to large amounts of malic acid) reduces fecundity of Aphids while alkalinity favours it (Monzen, 1926). The same author emphasizes the factor of hydrogen ion concentration. Presence or absence of glucosides, as for example, in Rosaceæ as a factor against a certain hymenopterous insect, is recorded (Verschaffelt, 1910). Relative susceptibility is governed by osmotic pressure of cell sap. Hoplocerambyx borer in sal trees are drowned in larval galleries by a copious secretion of resin (Carter, 1927). Milky exudations by latex hairs in plants like lettuce afford some protection by their sticky character. In the case of certain types of cotton, namely South American varieties, profuse gumming is produced by the proliferated tissue due to Pempheres attack, which engulfs the grubs. This factor is sought to be utilized in Coimbatore for breeding resistant varieties. In this connexion it is interesting to record the resistance of Wisconsin hybridcorn to Pyrausta nubilalis (Thompson, 1938).

For relationships as a factor of resistance.

The type of resistance based on nutritive values of different food plants has not received sufficient attention. Painter (1936) has given an impetus to such studies by laying special stress on this aspect. Insects like Aphids are known to react to the physiological condition of the host plant through food factor. The varying constitution and concentration of cell sap of different plants affect the biology and physiology of sucking insects like Aphids (Davidson, 1925). The same author has stressed the importance of carbohydrate-nitrogen ratio. A high nitrogen content contributed towards an increase of reproductive power (Uvarao, 1928). It is well known that different varieties of the same species or different parts of same plant do not serve equally well as food, for insects. This differential effect is more marked in polyphagous insects. Varying availability of specific food substances (quantitatively and qualitatively) and presence of vitamins greatly influence insect reaction in respect of oviposition, development, longevity and multiplication. Chemical and biological analyses of such varieties may enable us to know more about the character of the food;. and many resistant factors at present attributed to other causes may, on investigation on this line, turn out to be correlated to the food factor (Painter, 1936). The utilization of this phenomenon of varying nutritional value, opens up a wide field of possibilities in developing insect resistance. Recently, a few experiments on this line under controlled conditions on *Pempheres affinis,* were initiated and interesting results have been obtained which have been embodied in a joint paper by the writer and his colleague Mr. V. Margabandhu submitted for reading at the Science Congress Session, Lahore. Marked variations are seen to be produced by the different proportions of the constituents of the food such as Proteins, Carbohydrates, etc., on fecundity and longevity. Such studies may afford the basis for future work of economic and scientific value.

It is common knowledge that comparatively few instances of insect resistance of proved cropping value are on record. It may also be borne in mind that insects are the most adaptable forms among animals not excluding man; and that the problem is rendered more difficult when the species of insect concerned, is possessed of polyphagous instincts.

4. Rai Sahib Jai Chand Luthra, Lyallpur.

Application of Solar Heat for Control of Seed-borne Diseases.

The bright, hot and prolonged summer season of the plains of India and particularly of the Punjab may not be liked for its severe and uncomfortable heat. But it is recognized as a great blessing for its beneficial influence in preventing and checking many diseases of both animals and plants. The sanitary advantages of the sun in promoting health of human beings are too well known and India is envied for its natural boon of invigorating sunshine. Rays of the sun have been employed effectively in curing certain malignant diseases. Attempts have also been made in various other directions to harness the exuberant potential force of Sun's energy and utilize it for industrial purposes. In countries which do not enjoy this nature's free gift, ingenious electric contrivances have been devised for the application of heat and Radiotheory. But adequate attention does not seem to have been paid to the study of the bearing of sun-heat on plant maladies.

As far back as 1888 Jensen a Danish Botanist was the first Scientist to employ heat in the form of hot water to control loose smut (*Ustilago tritici*) in wheat grains. Subsequently hot air was tried for disinfection, but it was not successful because of the high temperature required to obtain the desired effect and consequent liability of the seed to injury. Hitherto Jensen's Hot Water Treatment has been the only effective method for controlling diseases carried by seeds. But it has been found cumbersome in actual practice and somewhat injurious to the vitality of the seed. During the last fifty years of its discovery, all efforts have been directed to simplify it. Excepting certain modifications with regard to duration of steeping in water and degree of temperature, the method essentially remains the same and is still difficult of adoption by unskilled farmers.

The loose smut of wheat has been prevalent to a serious extent in the Punjab. Fields containing 15–30 per cent smutted heads have been observed in several districts. At a moderate estimate the loss amounts to over 50 lakhs of rupees every year in this province. The writer while applying the modified hot water treatment with all its recently evolved simplifications felt the need of such a method as can be used by farmers whose ability to carry out treatments is an important factor in the success of measures of disease-control.

The use of sun as a lethal factor in place of hot water to kill the smut fungus in the seed was thought of as a possibility. Experiments were laid out in 1929 to give this proposition a trial. At Lyallpur the temperature recorded on black bulb thermometer in the Sun usually is 120°–122°F. maximum in June while the thermometer with black bulb in vacuo registered 150°–160°F. In the shade it is 113°–116°F.

Presoaking of the seed was retained as an essential principle underlying the method because it is considered a necessary preliminary step to render the fungus mycelium more susceptible to heat-effect. Several periods of saturation of seed with moisture and subsequent exposure to hot sun were tried on wheat seed taken from a highly smutted crop. After several years' experiments it was found that the smut-affected seed soaked in water for four hours and then exposed to the sun in the hottest part of the day in May-June from 12 noon to 4 P.M. or longer as required to dry the seed produced a smut-free crop. The disease was completely eliminated. The control plots contained 10–15 per cent of the disease. The method was tried at Pusa by Galloway and Mitra and was a success. In Bombay presidency also it was equally effective. Large scale experiments have been carried out during the last five years and in every case treated seed was freed of the disease. This method marks a great advance over the Hot Water Treatment in the matter of simple and easy manipulation, safety from injury to seed and a great saving of cost.

The use of the thermometer which the illiterate farmer can neither handle nor read has been dispensed with.

The heating of water which was a great hindrance in the way of treating large quantities of the seed is no longer necessary.

The application of the method has been extended to the smut disease of oats and it has proved equally effective to control it.

The author in presenting this discussion invites suggestions for further investigation on Solar Heat Therapy as applied to plant diseases.

5. MR. N. L. DUTT, Coimbatore.

He drew attention to the importance of the study of morphological characters with a view to discovering such as may be correlated to resistance of the different pests and diseases. He mentioned that in the sugarcane, bristly over the stomata are a possible adoptation against mosaic, but that they are not an unfailing criterion in selecting immune on resistant varieties. He also gave instances of Geographical variation of resistance by sugarcane in various parts of India. He also thought that for resistance to *Pyrilla*, leaves that stand erect as opposed to drooping ones and narrow leaves as against broad leaves had an advantage.

6. DR. A. V. V. IYENGAR, Bangalore.

Resistance or susceptibility is only a relative term, because in a diseased plot, some plants are found to grow for a time at least free from infection, while others show varying degrees of infestation. While the inability of a plant to withstand, say, insect attack may be correlated with defective nutritive supply, or inefficient root functioning or even traceable to an immature parent seed, it is an extraordinary feature that the cultivated species alone are recorded to be liable to be infected. On the contrary, a wild variety of the same crop is more or less immune from this attack and forms, in many cases, a parent for a resistant type. Besides, there is what is called disease avoidance, which can be brought about by late or early sowing, pre-treatment of the seeds or by roughing.

Susceptibility of crops to attack by pathogens and by insects is conditioned by environment, virulence in the case of the invading organism and the condition of the tissues such as succulence of the twiglets in the case of insects and other features which affect the active growth of the plants. Our knowledge of the susceptibility (antithesis of resistance) and predisposing factors in relation to the above invaders is quite inadequate. Two broad classifications may be adopted to summarize the diverse points: (*a*) mechanical and (*b*) biochemical. It is not proposed to examine the subject from the view-point of the external agent, viz., pathogens such as fungi, virus, etc., and insects, but mainly from the host plant, i.e., the infested plant or crop.

The first relates to the mechanism by which the organism effects an entry and subsequently establishes itself in a plant tissue or by which an insect species attacks a plant *en masse*, either by leaf defoliage, by killing the shoots, or by damaging the roots or by causing a discontinuity in the circulation of the food material, is probably dealt with by others. It is proposed to consider here only the internal composition of the plant in relation to plant diseases and plant pests. The factors of susceptibility may or may not be identical with those of predisposition.

The factors of resistance or susceptibility may be traced to (*a*) soil, which might affect the root development and root aeration. Being heterogeneous in nature, its composition varies at different points.

(*b*) The nutrient supply of the soil, either a deficiency of some essential elements such as lime, potash, etc. In these cases, the deficiency can be readily made up. Where such a deficit is induced by a pathogen as in the case of sandal spike and other diseases, this treatment affords no solution. The availability of nitrogen in adequate quantities to the plant determines its freedom from infection; sometimes an excess of it is harmful causing succulence of the tissues and predisposing the plant to insect attack. An apparently similar relation in regard to water supply has been noticed with reference to the cotton plants and insect attack.

(*c*) The reaction of the juice in the tissues. In certain bacterial diseases, the reaction turns alkaline while the resistant varieties are acidic in reaction.

(*d*) The presence of tannoid substances. Thus, in the case of onions, the red variety was found to be immune to bacterial infection and this was traceable to the presence of protocatechuic acid.

(*e*) Other compounds.

The several aspects mentioned above are discussed in detail.

7. DR. P. M. GLOVER, Ranchi.

I want to show that certain factors may be responsible for resistance to insect attack among trees. These factors are chemical and physical antagonistic features.

The lac insect *Laccifer lacca* feeds on the sap of a number of host trees, and may be considered to be a pest of the same type as many other *coccids*, but cultivated on account of the commercial value of its protective covering, lac.

Among species of lac hosts individuals are met with which are either not lac hosts, or poor lac hosts only. Such individuals are in fact resistant to attack by *L. lacca*. Such is the case among *Schleihera trijuya*, two botanically indistinguishable types occur, known in Chota Nagpur as Kareya and Charka. Kareya is a good lac host, Charka a poor one (i.e., resistant).

On investigation it was found that *L. lacca* requires a sap approaching neutratis for satisfactory growth (i.e., Ph. 5·8–6·0). The Kareya variety of *S. trijuya* has a sap approaching neutratis, while that of the Charka type is on the acid side.

Among lac hosts we do not want resistant strains, our problem is therefore the reverse of the usual one.

It was found that by injecting Charka trees with dilute alkalis such as Ammonia, it was possible to lower their degree of resistance, so that they became more susceptible to attack clearly indicating that in this instance it is sap acidity which is responsible for resistance to attack.

8. MR. P. M. VERMA, Lyallpur.

Referring to the subject of Resistance to Jassid attack in cotton in the Punjab, I remarked that work done at Lyallpur in the Cotton Research Section, Punjab Agricultural College, Lyallpur, has so far indicated that—

(1) The *Desi* varieties of cotton are not attacked.

(2) The inability of the Jassids to bread on these varieties, is due to the inability of the Jassid females to oviposit in the leaf veins.

(3) There is no inability on the part of the Jassid nymphs to develop on the resistant *desi* strains.

(4) Observations have shown that unhealthy plants both of cotton as well as of Brinjals were always more attacked by Jassids than neighbouring healthy plants.

(5) Resistance to Jassid attack varies with environment and locality. The variety Tanguis x, u_4 was resistant to Jassids in Africa, but becomes susceptible when grown at Sayodha (Punjab).

(6) 43F is the most progressive strain of American Cotton in the Punjab. It is fairly resistant to Jassids at Lyallpur, but not at Sayodha.

(7) L.S.S. is also resistant at Lyallpur, but is attacked fairly severely at Sayodha. This cotton, however, possesses great tolerance for Jassid attack.

(8) Environmental factors like the amount of light received, seems to be a factor in determining the resistance to insect attack. Tanguis x, u_4 plants covered by ordinary Muslin cages in 1937 behaved normally but they were severely attacked by Aphids, when the covering cage was of a thicker type during 1938. The Aphids disappeared as soon as cages were removed and full sunlight allowed to the plants.

9. DR. K. A. RAHMAN, Lyallpur.

We have been working on at Lyallpur now for a number of years Dr. Pruthi in opening the discussion referred to our work at some length.

It was about 1934 that we started work on the resistance of different Coimbatore sugar canes to the top borer (*Scirpophaga nivella*). We have found that in Co. Varieties 300, 301, 312 and 395 damage may be as high as 67% while in Co. Varieties 285, 331, 356 and 396 it may be as low as 13·2%. The larva on hatching bores through the mid vein of the leaf to reach the top of the cane. The harder the vein the lesser the chance for the larva to burrow in it. Therefore the character which enables the cane to resist the top-borer attack is the hardness of the mid vein.

It is not very long ago that the wooly aphis was introduced in the Punjab. We are familiar with its capacity for damage. In the Punjab it attacks apple and crab apple and we have found that plants such as 'Reons' (*Contoneaster Bacillaris*), 'quinine' (*Cydonia vulgaris*), 'Schiara' (Pyrus Sp.) and 'Pala' (Pyrus Sp.) both wild varieties of pear are completely immune from wooly aphis. Schiara and Pala are both commonly used as stock for apples the fruit of the Schiara being sweeter. We are now trying to evolve a stain of apple completely resistant to the wooly aphis. At this stage it is not possible for me to give the characters which enable these plants to resist wooly aphis attack. They may be chemical, physical, etc.

10. DR. F. R. BHARUCHA, Bombay.

In discussing this problem an important point was brought to attention namely that it is not sufficient to evolve a new variety of a plant immune to a certain pest and it is not merely the genetic constitution that is responsible for its immunity. The environment plays a great part and it is possible to convert an immune variety to a susceptible one or *vice versa* by even varying the pH of the cell-sap. This was done by Mr. Glover of the Lac Research Institute of Ranchi.

Thus the present writer wished to point out to the plant-breeders that it is high time that they paid attention to the nutritional aspects of plants. If this is done, perhaps, the process of creating immune varieties of plants and keeping up that immunity for a long time, will be much shortened and simplified.

11. MR. P. SEN, Calcutta.

In connection with the discussion on disease and pest resistance in crops, I would like to point out that in an experimental plot and under laboratory conditions a certain type of plant may be resistant to insect attacks but when these are introduced in the fields where the climatic factor will have a greater play the same plants may induce fresh attacks by insects.

I have noted that there are certain willow plants which will grow inside the experimental areas and remain resistant to attacks by the gall midge, *Rhabdophaga soliciperda* Duf., but when grown in nature these plants soon become heavily infested with the midges. What happens in nature is that after a heavy frost, a mould appears in certain parts of the plants which are then easily invaded by the insects. We must not, therefore, base our judgment on laboratory experiments only and should be quite sure as to what happens in nature before advocating the use of a certain variety of plant as resistant to insect attack.

12. DR. K. N. TREHAN, Lyallpur.

As also remarked by the President, I think the entomologist have been rather generous in establishing relationships with the plant-breeders and pathologists. In my opinion the co-operation of all the three is very essential for the control of pests and diseases. With a view to advocating, however, the importance of the entomologists the following may be considered of significance:—

1. There may be certain varieties of various crops but to evolve them and at the same time give them a fair trial on field scale, considerable time is necessary before they can be recommended to the *Zemindars.* Still, there are many more existing varieties and types. The problem, therefore will be either to discard all of them and wait till the new strains are established, or if they are to continue, the breeders must of necessity seek the help of the entomologists. The *Zemindars* require some ready remedy in which case even the breeders will have to resort to the ordinary measures such as hand picking, burning or spraying, etc. which prove very satisfactory.

2. In advocating the importance of the resistant varieties the breeders probably ignore the significance of such variable factors as are developed in the plants under different environments. Variations in the growth of a plant produce corresponding variations in its internal constitution which ultimately affects its resistance to disease and the relative incidence of insect attack. Reference in this connection may be given to the variations noted by us in the Punjab in the *p*H of the cell-sap of *Desi* and American varieties at different periods of their growth and the relative incidence of the white fly attack on them. All these party are worth paying a considerable attention.

13. DR. T. V. RAMAKRISHNA AYYAR, Coimbatore, the President.

Among the different methods which a farmer could adopt to save his crops from the depredations of plant and animal enemies and which would enable him to save the cost of fighting such enemies season after season, the growing of disease and pest resistant varieties of crops is pre-eminently the best; and if this method becomes possible to an appreciable degree it is not the cultivator alone that would be benefited but even the Government agricultural departments which can effect substantial savings by doing away with the need for plant doctors like Mycologists or Entomologists. How far this method becomes a practical measure is being investigated in different countries and has to be tried and watched.

From the different ways in which the term 'resistance' is used it looks as though it is capable of different interpretations. It may mean complete immunity from any disease or pest; it may indicate very little susceptibility on the part of the plant which will not affect its vigorous growth or normal yield; or again it might be applied to a plant which has sufficient vigour to revive thoroughly even after a severe attack. There is no doubt that any one of these results will be greatly appreciated. I doubt whether there is any plant which is completely immune to a disease or pest; even the most poisonous, thorny or otherwise protected ones are hosts of some diseases or insect pests. Basing our views on human experience we have often doubted whether any insects would touch such plants like chillies, tobacco, garlic, etc., and yet a host of insects do appreciable damage to these crops. As such it would be quite sufficient even if we are able to bring about a high degree of resistance or power to revive from an attack.

The most important pre-requisites on the part of the breeder who ventures to make trials in this direction are a thorough knowledge of the bionomics of the important enemies of the particular crop he is handling, and the outstanding facts in the physical, chemical and ecological reactions of the plant to its enemies. Speaking of Indian insects and their plant relations a few striking cases can be noted as peculiar. Fruit flies which badly infest grafted varieties of mangoes avoid the thick-skinned sour local varieties; the stem weevil of cotton in S. India prefers the succulent Cambodia variety of cotton to the hardy local races of that plant; the cotton leaf hopper appears to prefer non-hairy cotton leaf to a hirsute race; some longicorn borer beetles avoid certain trees wherein the rapid flow of sap drowns the grubs. There exist many such inhibitary features and other habits, and it is for the breeder to take advantage of such traits found both in the host and the parasite and try to evolve a plant which would withstand the attacks of such enemies. The difficulties are indeed many and the complications equally numerous. For, it is not disease and pest resistance alone which the plant breeder has to keep in view; there are many other desirable features which he is compelled to aim at side by side with this object. The sugarcane breeder wants his canes not only to be immune to borers or mosaic, but he wants to get a plant with high sugar value, good milling features, drought resistance, non-lodging tendency, etc.—an ideal race—with all the good features. The cotton breeder similarly aims not only pest or disease resistance but long staple, finer fibre, short duration, higher yield, etc. etc. In such many-sided aims complexities often set in; a very sweet variety of cane becomes easily susceptible to borers or mosaic, the yield from a hardy pest resistant race is too poor to encourage and so on. Again there are some peculiarities noted with both pests and plants in change of locality or geographical differences. Many a so-called resistant race of plant does not stand the test when tried in different climates. A rust resistant variety of wheat of Australia or America becomes easily susceptible to the disease in Europe or Africa. Similarly, there are some insects which show difference in their habits in different regions; nowadays some of these are regarded as biological races of the same insect. The notorious cotton boll worm of America though present in India rarely attacks cotton in India. The well-known tobacco horn worm of the U.S.A., West Indies, etc., though found in India does not feed on tobacco in India and so on.

In spite of all these difficulties and complications, it is quite possible that success might attend the lucky breeder (it is practically a lottery chance) who may be able to breed desirable races of plants which will resist pests and benefit the cultivators by employing various methods such as selection, grafting, hybridization, etc. There are of course a few varieties of different plants especially cereals and fruit trees, reported from different regions with different degrees of resistance to particular pests. Some varieties of grapes and apples are said to be *Phylloxara* and *Wooly blight* resistant in different regions, and some canes to borers or mosaic, though in some cases confirmatory evidences are not sufficient to warrant any definite conclusions. But one thing may be noted; as long as this work of man is one which is a sort of warfare with the natural balance of life among organisms of different kinds, this fighting with nature will have to be continuously carried on, since no permanent results can be achieved; for, both plants and their enemies are sure to adjust and adapt themselves to their new hosts. As far as insects are concerned their powers of adaptability to new surroundings are extraordinary, and the breeder has, therefore to go on breeding new varieties one after the other so that if one race loses its desirable features another may be ready to take its place.

In conclusion the President pressed the great need for co-operation between different scientific workers instead of finding faults with one another.

XI. EROSION AND DRAINAGE PROBLEMS IN INDIA.

(Sections of Agriculture, Physics, Veterinary Research, Geography and Geodesy, in co-operation with the Indian Society of Soil Science and National Institute of Sciences of India.)

DR. MCKENZIE TAYLOR, Lahore, presided and opened the discussion.

Opening Remarks.

In Northern India erosion which affects conditions in the plains is probably confined to the hills below 7,000 feet in height. Above this height the weathering of the rocks is mainly due to the action of frost and ice and results in the production of the grey silt which is present in the rivers during the pre-monsoon period. The red silt which is characteristic of monsoon floods is derived almost entirely from the lower hills. Curiously enough erosion is probably not so serious in the high rainfall areas as in those of low rainfall. In the high rainfall areas plant growth is rapid and a good soil cover is soon produced; in areas of low rainfall the plant cover is thin and as a result erosion is a much more serious problem.

Erosion is difficult to measure; a statistical examination of the rainfall and river discharges of the Ravi catchment has not resulted in any definite conclusions regarding the increase in the peaks of floods or the falling off in the river supplies during the cold weather. Indirect evidence of the effects of erosion are, however, available. The fall in the water-table of certain areas dependent for their underground supplies on the absorption of the rainfall in hill areas, the comparison of early maps with those of the present day and the topography of the catchments, are examples of this indirect evidence. Experimental evidence as to the effect of the plant cover in preventing erosion has been obtained in many countries and recently at Madhopur in the Punjab. That erosion is taking place and that the consequences may be equally serious in the hills and plains in India should be accepted without further research, and measures should be adopted immediately to secure control.

While the effects of erosion on the rural economy of the hills is difficult to assess owing to the lack of data, there are a number of serious consequences of great importance in the plains. The silting of canals, the maintenance of canal headworks, the desiccation of certain areas and the flooding of others are effects which are of importance both to the State and to the individual. In some provinces Government is taking action to control erosion but unless the importance of the problem can be brought home to the individual and his co-operation secured to alter the present practices, the results of Government action are likely to be fruitless.

Drainage is again a subject which affects both the State and the individual especially in areas with a highly developed irrigation system. That a rise of water-table will follow the introduction of irrigation is almost universally true. A notable exception is the United Provinces. This is due to the natural drainages which have developed as a result of the high rainfall. It follows that artificial drainage is more of a necessity in areas of poor rainfall than in areas of high rainfall since in the former the natural drainages are not well developed.

The causes of the rise in water-table consequent on the introduction of irrigation have been investigated in the Punjab. The factors responsible for the rise are, briefly, increased absorption of rainfall due to cultivation, decreased run-off due to the blocking and cultivation of drainages, seepage from canals and direct additions to the water-table resulting from the irrigation water spread on the fields. Of the measures that can be taken to control this rise in the water-table drainage is probably the most feasible.

The effects of the rise in water-table are again serious to both the State and the individual. The waterlogging of the land affects the health and income of the population. The deterioration of the land due to salt accummulation affects the livelihood of the individual and in time the revenue of the State. The revenue of the State is not affected immediately since a certain proportion of the land can go out of cultivation without decreasing the intensity of cultivation allowed. In the Punjab where the Rabi intensity of cultivation allowed is 50%, theoretically 50% of land can go out of cultivation without affecting the provincial revenues. There is, however, the humanitarian aspect of the problem since the whole of an individual holding may be deteriorated with disastrous effects on the health and livelihood of the *zemindar*.

Control measures will always be expensive. When, however, the well-being of the individual is dependent on effective control, the necessary measures must be taken if the State is to survive.

If the control of rise in water-table cannot be secured an alternative method of dealing with the conditions must be devised. In the past an irrigation system has been grafted on to an existing system of agriculture. For the future it will be necessary to modify agricultural systems to render them suitable for irrigation conditions.

2. DR. R. MACLAGAN GORRIE, Lahore.

Soil Erosion in India.

There has recently been a general awakening amongst the Indian public to the fact that soil erosion is a great menace, but owing to lack of real knowledge and an inherent mistrust of Government's intentions, the education of the public in the real facts of the case becomes a moral obligation falling upon those who have some real knowledge of the soil erosion question through their scientific training and experience of natural soil phenomena.

A general statement of the problem in India is that:—

(1) all sloping lands even when protected by forest cover contribute a large share of rainfall to streamflow;

(2) slopes unprotected by natural plant cover suffer considerably from soil erosion;

(3) the absorbtive capacity of the soil surface is destroyed by the closing of pore spaces and by the breaking down of 'crumb structure' which is nature's method of ensuring moisture movements in soil;

(4) increased surface run-off leads to loss through 'sheet wash' of the surface soil;

(5) the sand-papering action of grit-laden water leads at a later stage to deeper gullying;

(6) immediate effect of gullying is to destroy underground water-table which drops deeper, affecting wells and springs;

(7) the regime of rivers is upset, tending always towards higher and more sudden flood peaks, with longer intervening low levels when rivers are starved;

(8) deposition of detritus in lower stretches of a river raises the bed, causing wider flooding of plains and meandering of river into new channels.
(9) navigation value of large rivers is ruined by sand banks.
(10) incidence of water borne diseases in men and cattle is increased through wider distribution of casual water from floods.

The problem can be met by a judicious combination of the following lines of action, grouped under the three main divisions of agricultural land use :—

Livestock and Fodder.

(1) reduction of surplus livestock ;
(2) grading up of flocks and herds ;
(3) grass land improvement ;
(4) encourage voluntary and rotational closures ;
(5) partition of *shamilat* (common grazing land) to develop individual ownership ;
(6) *panchayat* management of grass lands ;
(7) replace grazing by grass cutting and stall-feeding of hay ;
(8) develop grass markets for profitable disposal of surplus cut grass ;
(9) use green fodder crops and silage ;
(10) restrict immigrant flocks.

Forest.

(1) encourage the village as the unit for forest improvement and protection schemes under co-operative or *panchayat* organization ;
(2) reclamation of ravine lands for grass and forest produce ;
(3) reclamation of flat lands in torrent beds, which are often cultivable after a period under forest conditions ;
(4) village plantations for fuel and timber ;
(5) planting of fodder trees ;
(6) rotation of lopping fodder trees ;
(7) control of *nautor* grants (breaking virgin land for cultivation) ;
(8) protection of existing forest ;
(9) shelterbelts.

Ploughlands.

(1) *watt bandi* and contour terracing to retain rainfall and reduce run-off ;
(2) remission of land revenue to encourage *watt bandi* ;
(3) consolidation of holdings to allow better lay-out of field terracing ;
(4) patwaris and district civil staff to be given short courses in *watt bandi* and field improvement ;
(5) co-operative organization for land improvement projects ;
(6) use of live hedge plants to replace dry thorn twigs ;
(7) encourage use of compost manure ;
(8) find legume or grass crop to sow on fallow (bare fallow land gives a high run-off) ;
(9) improvement of cultivation methods for soil-wasting crops such as potatoes ;
(10) restriction of cultivation on very steep slopes.

3. RAO BAHADUR B. VISWA NATH, New Delhi.

Drainage Problems of India.

Water is the only vehicle by which nourishment is conveyed from the soil to the crop growing on it and the water can also do immense harm to the crop if it is too much and stagnant. Under natural conditions, an adjustment between the nature of soil and the amount of rainfall and generally such undulations and porosity of land occur as to retain sufficient water to meet the requirements of the type of vegetation thereon. The type of vegetation also adjusts itself. Thus the conditions have attained a state of equilibrium. With the introduction of artificial conditions, such as irrigation systems and new crops, the equilibrium is disturbed and unless arrangements exist for the removal of surplus water, troubles are bound to occur.

Land drainage is, therefore, an important factor in any system of irrigation agriculture. Inadequate and inefficient drainage leads to evil consequences such as water-logging and development of alkalinity and salinity in the soil. The soil and the water put on it are subject to a series of interactions and the intensity of the reactions and the final result are governed by the nature of the soil, its composition, the quality and quantity of water put on the land and on the permeability of the soil and on the climatic conditions.

If the soil is already laden with salts or is of such a nature as to admit easy decomposition, continuous irrigation makes considerable difference. Under continued irrigation alkalinity will be more in evidence and salinity is diminished due to dilution and hydrolysis. Under intermittent irrigation, alkalinity is diminished but salinity may grow to concentrations injurious to crops. If soils and waters are rich in sodium salts and if this state is combined with low calcium content, the composition of soil clay may be so changed as to render the soil impermeable and drainage impossible. Where soils and waters are rich in calcium salts excessive salt concentration may cause trouble. In these conditions large additions of water to keep down the salt concentration, leads to a rise in the underground water table. The problem then is to lower the subsoil water level to prevent damage to crops. Several irrigated tracts under canals and wells present these problems.

Drainage as a curative process is vastly more difficult and ultimately expensive and even then with imperfect results than drainage as a preventive measure. Typical examples of these are again found in the several irrigation systems in the country.

4. Mr. Y. D. Wad, Indore (C.I.).

Soil erosion and its control in Central India and Rajputana.

Annual losses of soil fertility are severe both in Central India with its high rainfall and in the drier Rajputana. The result is that the benefits of better cultivation and manuring cannot usually be fully obtained.

The sharp intermittent showers characteristic of the local rainfall are primarily responsible for the erosion.

The loose surface layers of heavy soils such as the black cotton soil in Malwa are quickly mobilized by such showers, being flooded by rain-water which cannot penetrate compact soil in lower layers as fast as it falls on the soil surface. The existence of cracks and burrow-holes of rodents and other animals start gully formation. In the light soils of a very fine texture such as exist in Rajputana the force of falling rain leads to their compaction which prevents the rapid penetration of rain water in deeper regions. The surface soil is therefore rapidly washed away. The fertility differences between fields in these tracts are predominantly determined by the combined operation of the agencies of erosion and the topographical situation of the field. In the drier parts of Rajputana wind erosion has its own share.

Erosion due to rain can be effectively controlled by:—

(1) preventing the entry in the fields of outside water at its source by a suitable contour-bund laid between two principal storm-water channels and

(2) by preventing excessive acceleration of the speed of rain water flowing over the area between two natural drains with the help of similar contour-bunds laid across the slope and suitably distanced.

The unbunded edges of fields and both sides of bunds are strengthened by maintaining a cover of useful grasses, legumes and other plants. The Kharif crops are sown across the slope.

Gully formation is likely to start in fields due to chance depressions or unevenness produced during routine operations. This is checked by draining on either side by means of furrows, the accumulated water in such depressions in order that it may be more evenly distributed.

The tendency wherever observed of falling rain to run rapidly in narrow streams is checked by broad barriers of waste grass or collected weeds.

Evidence is accumulating in the form of the increased vigour and evenness of growth, earliness and higher yields which indicates the great rapidity in the rise of fertility of the fields when thus protected from erosion effects.

The adoption of measures for controlling soil erosion seem to be the first essential step towards agricultural improvement. It will be effectively done only by State initiative and organization as individual holdings do not always coincide with the portions of land naturally suited to become unit-areas for erosion control.

5. DR. P. M. GLOVER, Ranchi.

I should like to describe to you briefly a small experiment carried out at the Indian Lac Research Institute, Namkum, Ranchi, Bihar, as it bears out in many ways what Dr. Gorrie has just said.

The plantation at Namkum faces West, and is on a gentle slope roughly ¼ mile in length. It is stocked with *Acacia catechu, Butew frondosa, Schleichera triyuga, Zizyphus jujuba,* etc. The canopy is however incomplete as many of the trees are small, and many are in use as lac host and are consequently frequently cropped and pruned.

The soil is sand and clay, and in places there is a clay pan at 5′-6′ and in others at 6′ the soil is mainly stones. The area was ploughed and cultivated, and waterlogging occurred during the Monsoon. A good deal of surface erosion occurred also each year.

In about 1931, very unwisely a herring bone drainage system was laid down in an area of about 10 acres, with a main drain, 3′ wide and 2′ deep, running down the slope. Waterlogging was diminished, the drainage system however was subject to serious scouring and in 1937 the main drain was something like 10′ wide and 8′ deep.

In May, 1937, cultivation was abandoned throughout the whole area, which was allowed to grass over. In the 9 acre block the herring bone drains were filled in, and the area was contour trenched. Trenches were about 2′ wide and averaged 3′ to 4′ in depth at intervals of about 70 yards.

In the Rains of 1937, the whole area was only partially grassed over, and some erosion occurred. In the trenched area, very little erosion occurred. The trenches in the lower part of this area however overflowed, and the ground became practically a marsh.

In May, 1938, at the most arid time of the year, when there had been practically no rain for months, soil moisture samples were taken in pits at depths 1′, 3′, and 6′ in both trenched and control areas. The soil moisture content was found to be consistently higher in the trenched area than in an apparently similar control area. This is believed to be due to the effect of contour trenches on gently sloping land with an incomplete grass cover.

In the Rains of 1938, the grass cover became almost complete throughout the area. Overflowing of the trenches in the lower part of the trenched area again occurred and extreme marshyness was the result. In the early Rains, wide shallow grass-turfed escapes were made running between the lower trenches, and from the lowest trench a similar wide escape was made. The effect was the immediate prevention of water-logging and marshyness. It would appear that contour trenches with wide overflows of this type are an excellent form of drainage for this type of land. Practically no erosion occurred throughout the whole area, due to the grass cover.

In November, 1938, when the Monsoon was over, further soil moisture samples were taken, in both trenched and control areas. It was found that the difference in soil moisture content in the trenched area was not consistently in excess of that in the control. In some instance the soil in the control area was more moist than in the trenched area. In the lowest sample pit in the control area, water was met with at 5′.

These results are believed to indicate that a grass cover alone, when complete, is sufficient to prevent erosion and conserve soil moisture on gently sloping land, and that contour trenching is a valuable method of draining gently sloping land without the fear of erosion occurring.

It is hoped to carry this experiment further in 1937, and to publish the result obtained in due course.

6. **Dr. A. N. Puri**, Lahore.

Spoke about the erosion of mud walls and mud-plasters. An apparatus was described for measuring erosion in any particular soil. A method of preventing erosion of mud plasters was described; briefly it consists in mixing 0·1 per cent sodium carbonate and 5 per cent cement to the soil used for mud plastering.

7. **Dr. V. I. Vaidhianathan**, Lahore.

In dealing with the question of stability of earth slopes, as in the case of the slopes of hills or side slopes of canals and rivers, the density and the shear are the most important factors. Different types of soil have different angles of rupture and for any particular type, the angles of rupture under similar conditions seem to be equal. The density depends mainly on the moisture content, and the shearing resistance on the type of soil, moisture content and its structure. The shear strength is usually expressed in the form of an equation

$$S = C + n \tan \phi$$

where S is the shearing strength, C is the cohesion, n is the applied norma stress, and ϕ is the angle of internal friction.

The shearing resistance of clay soils is largely influenced by their moisture content, whereas in the case of coarse grained material, the main resistance to shear is caused by the internal friction. In the case of clay soils, the internal negative pressure causing the adhesion is due to surface tension and in very fine clays may even be of a molecular nature. Stratification of the soil plays also an important part, because it affects the internal friction at the surfaces of the strata. These are some of the main points affecting the stability of earth slopes.

XII. COMPOSTS.

(Sections of Agriculture, Medical and Veterinary Research, in co-operation with the Society of Biological Chemists, India.)

Dr. T. V. R. Ayyar, Coimbatore, presided.

1. **Dr. C. N. Acharya**, Bangalore.

A Comparison of Different Methods of Composting Waste Materials.

A comparison of different methods of composting town and farm wastes, as judged by plot trials in the field and by nitrification experiments in the laboratory, showed the superiority of the 'hot' fermentation process over the usual aerobic methods. The former gave a higher recovery of organic matter and of nitrogen than the latter (about 1½ times) and the resulting manure was equally efficient in crop production in several cases superior. Starting from the same amount of original materials, it is possible, by suitable dilution with soil, to obtain by the hot fermentation process about 1½ times as much manure as is obtained by the usual aerobic methods and containing the same percentages of carbon and of nitrogen. Indications were obtained during the course of the work that the rationale of composting waste materials needs a re-examination. The satisfactory behaviour of the hot fermented composts in the field would go to show that in the aerobic methods, as usually followed, the oxidation is carried to an extreme stage when even the less oxidizable fractions are attacked and thus avoidable losses of dry matter and of nitrogen occur. The recent experiments at Rothamsted and in Ceylon on composts *vs.* uncomposted material, were also discussed.

2. MR. Y. D. WAD, Indore (C.I.).

Composting methods.

In ancient times both in the east and the west the manufacture of humic manure and applying it to the field was considered very essential for increasing soil fertility. The utilization of mineral manures for profitable cropping obscured the importance of humus to stable agriculture for a time until recent scientific work emphasized it again. The main problem before the workers was how to speed the rotting of farm yard manure and how to increase its supply. The researches of Hutchinson and Richards led to the Adco process. Fowler concentrating on the speeding up of the decay evolved the activated compost system. Howard aimed chiefly on the utilization of all types of residues with a view to increase the supply of humus and save to the Indian cultivator part of the cattle dung for fuel, a satisfactory substitute for which has not yet been found. The Indore Process was thus evolved and found itself suitably modified in several ways to suit different raw materials and environmental condition. This process is at present very widely practised as a routine all over the world.

Fowler in later stages thought that partially anærobic conditions at a later stage may be sometimes advantageous. The author had found that in certain conditions three turns gave a product inferior to that produced by one turn only. It was considered that with a mixture of residues of different degrees of fermentability it was likely that the more easily decomposed fractions may be oxidized before the backward fraction is sufficiently advanced in decay. Under such conditions the losses may be reduced by lessening the number of turns which are meant to restore to the original level, the æration of the heap which has been reduced due to shrinkage.

While investigating the possibilities of the hot fermentation process Acharya has concluded that a better conservation of carbon is achieved when anærobic conditions are established after an initial ærobic decay.

Howard has recently evolved what is called sheet composting which seems to suit wherever labour is scarce. Residues of field crops are composted *in situ* in the field without collecting and removing them. The conditions in sheet composting are perhaps semi-ærobic. Similar attempts at simplification are being done by applying waste organic matter direct to the soil with inorganic reinforcements.

Perhaps the most economic and convenient method will be a preliminary ærobic decomposition to a suitable stage followed by application to the field direct, a few weeks before sowing time.

3. Dr. P. E. Lander, Lyallpur.

(1) In view of the deficiency of organic matter in our soils, there is great scope for the introduction of compost manures provided they can be prepared cheaply and are well decomposed before application.

(2) Different types of waste material which can be used and conditions necessary for obtaining composts of a suitable quality from these are described briefly.

(3) The method employed at Lyallpur for making composts is briefly outlined.

(4) Information is given on the composition and value of the composts obtained from different kinds of waste material.

(5) Results of field trials with composts in relation to F.Y.M. and green manure are briefly discussed.

(6) It is concluded that composts, though not a substitute for F.Y.M. or green manure, constitute a useful supplement.

4. Dr. H. R. Cooper, Assam.

The results of field experiments comparing effects, on tea, of humus composts and similar materials, against sulphate of ammonia are presented. Trials are also included of materials used for making composts applied direct to the soil in the 'raw' state without fermentation. The data obtained, so far, lead to the following general conclusions:—

(1) Humus composts have a very low efficiency per unit of nitrogen compared to sulphate of ammonia. If there is any benefit from 'auxiliary food factors', it is much more than offset by low availability of nitrogen.

(2) Fermentation before application to the soil, in the case of straw does not increase its value as manure, and in the case of leafy material reduces its value as manure.

5. Dr. M. R. Madhok, Lyallpur.

Dr. Acharya has indeed made an interesting study on the subject of composts, but I am of the opinion that some arbitrary time limit should be fixed for the first step of aerobic decomposition. It would be advisable to conduct a systematic study and indicate at least approximately the state of decomposition before the conditions are made anaerobic. I would suggest that such a stage be fixed to a time when a greater part of the easily available organic matter has been decomposed and before the process of biological nutrification has set in.

In comparing differently prepared composts for their availability it would be more reasonable to compare quantities containing equal amounts of available plant nutrients, particularly nitrogen, rather than to compare equal weights irrespective of the nutrient concentration.

6. Dr. A. Sreenivasan, Indore.

Dr. A. Sreenivasan, referring to Dr. Acharya's paper, said he would like to ask the following questions:—

(*a*) How well the hot fermented manure keeps under aerobic conditions without losing nitrogen?

(*b*) Whether there would be any difference if waste organic matter is applied direct to the field after an initial aerobic fermentation such as is given during the beginning of the Edelmist process?

(*c*) Whether it is not fairly certain that the increased nitrification and yield of crops is due only to the increased amount of nitrogen added as manure in the case of the hot fermented manure?

7. Mr. K. R. Narayana Iyer, Trivandrum.

A great deal of work has been done in Travancore on the preparation of composts from farm-refuse such as leaves, crop wastes, etc., and town-refuse, mainly comprised of night-soil and street-sweepings. The old method of rotting down the material in pits and the new Fowler's process of composting, in which the principle of activation is employed, are described. The main advantages of the new method are: (1) that it takes a much shorter time, (2) that it entails an exceptionally high fermentation temperature which eliminates all noxious constituents from the final product, and (3) that it yields a continuous supply of high-grade compost. The chemical composition of composts made from water-hyacinth, night-soil and street-sweepings, etc., is given. The results of pot culture and plot experiments to determine the manurial value of these composts, as compared with such organic manures as cattle manure, etc., are also furnished.

8. Dr. B. K. Mukherji, Cawnpore.

The Indore process, modified to suit local conditions, has been found to be satisfactory for the composting of agricultural wastes, in areas where water is easily available. In other areas, where there is difficulty about water, a simplified 'Rain-Water' composting technique has been evolved, wherein the litter is stacked during the dry season and composted during the monsoon period. Methods are described suitable for adoption in villages where the cattle are either maintained in huts or are kept in the open.

When the Indore process was applied to the disposal of town-wastes including night-soil, it was found that maggot-breeding was not checked in the earlier stages (up to two turnings) and the temperature also did not exceed 45°C. A 'dry' method for the disposal of habitation-wastes has been evolved wherein the urine and slop water received from public latrines are not added to the compost heap, but only the night-soil, ashes and household rubbish are included. The 'dry' process was found to eliminate fly-breeding quite satisfactorily and to produce much higher temperatures (60°–70°C) in the compost heap.

Dr. Acharya, replying to the questions raised, said that in the hot-fermentation process of composting, the aerobic treatment was stopped when the temperature curve had reached its maximum and had after that fallen to about 50°C. This generally took about 5 to 6 days and indicated the stage when the most readily fermentable portion had been decomposed. Temperature would be a better criterion for marking the above stage rather than chemical analysis, since in the present indefinite stage of our methods of analysis of the complex chemical groups present in the compost heap, it would be difficult to draw by chemical analysis a hard-and-fast line between the easily decomposable and the less easily decomposable constituents. The speaker mentioned that very little biological nitrification took place, under the conditions of the hot-fermentation method, even if the preliminary aerobic treatment were prolonged.

Referring to Dr. Sreenivasan's questions, Dr. Acharya said that (*a*) in the ordinary farm practice. the manure heap would be opened only when required to be put on the land and the losses of nitrogen after the manure is put on the land would be common to all systems of composting. (*b*) Even if the compost, after the preliminary aerobic treatment of a week, is fit to be put on the land, it will have to be stored till needed for the above purpose in the cultivation cycle; and the work of Russell and Richards has shown that anaerobic conditions of packing are most effective in preventing nitrogen losses.

Dr. Acharya agreed with the observations of Dr. Madhok and Dr. Sreenivasan that the higher crop yields obtained by use of the hot fermented composts were due to the better conservation of nitrogen in that process and the higher percentage of nitrogen contained in those composts. But as composts and farmyard manure are usually purchased by their weight and not on the basis of their chemical composition, and as there was still a controversy as to whether composts exerted their beneficial action due to their organic matter content or to their nitrogen content, he had applied equal weights of the differently prepared composts to the experimental plots.

XIII. EXPERIMENTAL FIELD TRIALS.

(*Section of Agriculture, in co-operation with the Statistical Conference.*)

The discussion on Agricultural Statistics was held jointly with the Agricultural Section of the Indian Science Congress at 11 A.M. on Saturday the 7th January, 1939, under the Chairmanship of Prof. K. B. Madhava of the Mysore University.

Dr. R. J. Kalamkar (Nagpur) opened the discussion on 'Crop Cutting Experiments and Sample Surveys in Agriculture' by describing the results of certain recent crop cutting experiments in Central Provinces. Discussing the usual 'anna' estimates of crop forecast, he pointed out how these were clearly biassed by the psychological attitude of the reporters. Dr. L. A. Ramdas (Poona) discussed the use of meteorological data in preparing crop estimates and the need of carefully planned experiments. He mentioned in this connexion a special scheme on which work was expected to be started at an early date. Prof. Mahalanobis pointed out the need of inter-provincial co-operation in evolving standard methods for crop-cutting experiments, and proposed the appointment of a small committee for collecting information relating to such experiments. Mr. A. C. Mukherji (Baroda) and Mr. Mazhar Husain (Hyderabad) supported this proposal and the following resolutions were passed unanimously :—

(i) Resolved that a Committee with powers to co-opt consisting of Bhai Balmukand (Lyallpur), Mr. Mazhar Husain (Hyderabad), Dr. R. J. Kalamkar (Nagpur), Mr. Khatam (Bombay), Mr. A. C. Mukherji (Baroda), Mr. Gopala Krishna Raju (Madras), Dr. L. A. Ramdas (Poona), Dr. B. L. Sethi (Cawnpore), Rao Bahadur M. Vaidyanathan (Delhi) and Prof. P. C. Mahalanobis as Secretary be appointed to collect information and report on available material relating to crop-cutting experiments and other sample surveys in agriculture which have been recently or are now being conducted in different provinces and States in India with a view to the formulation of suitable all-India standards with necessary regional modifications in regard to the sampling technique.

(ii) Also resolved that the work should be done as far as practicable with the help of and in active co-operation with the Imperial Council of Agricultural Research.

Mr. K. Kishen (Calcutta) then read his paper on 'Split-plot technique in field experimentation' and a Note on 3×3×3 factorial arrangement and also presented a paper on 'The Application of Co-variance technique to field experiments with missing or mixed up yields' by Mr. K. R. Nair (Calcutta). In this paper Bartlett's method of co-variance introducing certain pseudo-variates has been used for obtaining estimates of missing values and yields of K mixed up plots as also the appropriate treatment sum of squares in the case of Randomized Blocks and Latin Squares.

Mr. G. K. Sant (Indore) read his paper on an estimate of error from unreplicated experiments. The following papers were taken as read: 'Sampling in Sugarcane Experimental Work' by Mr. M. Subbaiya; 'Some balanced confounded arrangements for the 5r type of experiment' by Mr. K. R. Nair; and 'A 10 × 10 quasi-factorial experiment at Chinsurah with 100 strains of Rice' by Messrs. K. R. Nair, S. C. Chakravarti and P. C. Mahalanobis.

XIV. THE PLACE OF PHYSIOLOGY IN GENERAL EDUCATION.

(*Section of Physiology.*)

PROF. N. M. BASU, Calcutta, presided.

1. PROF. B. T. KRISHNAN, Madras.

Religion and superstition were for a long time, both in the West and the East, hindrances to the acquisition of any detailed knowledge of the structure and functions of the human body. It was about the middle of the sixteenth century that there was a revolt, in the West, against religious authority and Andreas Vesalius was able, by actual examination and dissection of human bodies, to publish in 1543 a book on the structure of the human body (De corporis humani fabrica), and thus lay the foundations of modern human anatomy. It was about three-quarters of a century later that William Harvey laid the foundations of modern physiology by his discovery of the circulation of blood.

Although marked progress was made in physiology by the middle of the nineteenth century, the general education imparted in Great Britain at that time ignored altogether instruction in natural science. The mistress of a ladies' seminary is said to have remarked that it was 'not quite respectable for persons to know about their insides'. It was considered then that 'such gruesome details should be learnt only by the doctors'. It was Professor Huxley who first criticized the educational policy of his day and it was largely due to his influence that the teaching of biology and with it that of human physiology was introduced into schools in Great Britain.

In India, physiology as a science was, I believe, very little heard of till the advent of English education. The ancient Hindu medical literature as embodied in '*Charaka*' and '*Susrutha*' possibly contain some references to the normal functions of the human body. But, owing to the tendency in India of searching for things spiritual in the ages gone by and even at the present day amongst those who believe in and practise *Ayurveda*, the enquiry into biological and medical truths has been made only by the application of spiritual knowledge and by mere interpretation of the works left by the ancient writers. There has never been any attempt to improve on the knowledge inherited by direct and practical investigations and to put forward any scientific publications for the information of those who seek enlightenment.

Even with the introduction of Western scientific education in this country, owing to the periodical changes in the educational policy in different provinces, physiology as a science subject has not been regularly included in the curricula of studies either in the schools or colleges. At the Madras University, physiology was, about thirty years ago, a subject for compulsory study in the First in Arts course which corresponded to the present Intermediate standard but was not taught either in the lower or higher classes. At the present day, only such of the intermediates who study natural science as an optional subject get some acquaintance with the elements of physiology and these are very few indeed. Although very recently physiology has been included as one of the optional subjects for the B.Sc. only one science college at Madras has undertaken the teaching for the subsidiary standard. I believe, at other Indian Universities, physiology has been taught for the B.A., or B.Sc., standard for a longer period than at the Madras University. It is deplorable that, under the present scheme of education, specialization in an optional subject commences very early in the school course and is carried on up to B.A. or M.A. in the same subject. The result of such specialization is that majority of the graduates, undergraduates, and school-finals who are turned out year after year with history or philosophy as their optional subject are unacquainted with even the basic elements of physics, chemistry or natural science.

If the citizens of a country are to build up sound and healthy bodies, teaching in elementary biology and physiology should form an essential and important part of general education. It is the fashion in this country at the present day to form national health associations and to start maternity and child-welfare centres, ante-natal clinics, nutrition centres, cattle-breeding centres, etc., with the object of educating the public on problems of sanitation and personal hygiene and improving the health and nutrition of men and cattle. If the propaganda work carried out by these associations and centres is to be a success, if the citizens are to understand what is preached on the platform and published in magazines and newspapers, if the people are to learn the secrets of perfect bodily health, it is imperative that the teaching of physiology should be a part of the general education imparted in the schools and colleges. Suitable health readers, such as those published by McDougall's Educational Co. Ltd., and Vincent T. Murche's Science and Nature Knowledge Readers containing lessons on the elements of animal and human life, should be introduced in the lower standards of the schools and the knowledge of natural science should be gradually developed in the higher classes. In the college course, human physiology should be a subject for compulsory study and should not be one relegated to an optional group.

The aim of modern medicine and the declared ultimate goal of the medical profession is prevention of disease. Maintenance of sound and healthy bodies by preventing illness is certainly a better ideal than bringing about radical cures of illnesses already contracted. For the successful attainment of this goal, it is very necessary that there should be co-operation between the members of the medical profession and the citizens of the country and an effective co-operation can only be expected when the citizens are equipped with a knowledge of the working of the human body and the laws of bodily health and personal hygiene. Such knowledge will also be of great value to the citizens to counteract the influence of and to protect themselves from becoming easy victims of unscrupulous quack-doctors and barber-surgeons. Charlatanism and witchcraft could be abolished and be given a decent burial more easily and more expeditiously with the help of such enlightened citizens. The public credulity in regard to advertised remedies can also be removed to a very large extent.

A knowledge of the working of the human body, apart from its usefulness in matters of health, nutrition, and prevention of disease, has also its influence on the moral conduct of individuals. The story of the human body is the 'story of a great unity'. In this sense, the functioning of the various parts of the body arouses a new interest. It is a remarkable example of a perfect society, where the component units, though they are divided in labour and appear to have different functions, all work in unison with one aim and purpose, i.e. the safety and well-being of the whole body. In a healthy body, there is co-operation, peace and harmony instead of confusion and disorder. This knowledge ought to serve as a great lesson for the body-politic and is bound to have a great sobering influence on the minds of individuals who have a tendency to run riot. No one who has acquired a knowledge of this great unity and no one, who has realized that the drama of such life ends with the dissolution of the physiological existence of this unity, can be without a feeling of deep humility.

The story of the human body is also 'a story of a great work of art'. It is not a mere list of anatomical names. The more one comes to know of the exquisite beauty of its structure, the greater is the admiration and interest aroused. The finest work of art, however ingeniously it might have been carried out by man, cannot excel this God's creation. Attempts have been made since the time of Hippocrates to learn the truth about its working, but nature has been baffling mankind at every state, however advanced the intellectual attainments and the scientific progress may be. The more is learnt of this marvel of nature, the greater is the realization of the limitations of man's intellect and capacity to unravel and explain more fully the varied complex activities of the human body. It is a great pity that majority of the so-called educated spend their lifetime in this world in complete ignorance about this great work of art.

2. Dr. R. K. Pal, New Delhi.

The study of physiology is a neglected cause by the universities as well as by the public. Everybody ought to know something regarding structure, functions and mechanism of working of different vital organs to prevent and cure minor ills to which the frail body is subject from time to time. Physiology is thus a very important practical subject which should be introduced in schools as an integral part of the compulsory subject hygiene, so as to create interest of young minds in the working of their own body mechanism for keeping good health and living long lives. So also it should be introduced in the intermediate, graduate and post-graduate courses. Very few universities in India teach physiology in all these courses. Rangoon has introduced a medical group comprising physiology, anatomy and biology for the degree course—after which graduates join the clinical course for graduating in medicine in three years' time. Those who leave in the middle of the medical course for various reasons will, if the same thing is done by other universities, thus leave with a degree in general science, and may then seek their career in some such lines, such as veterinary work or nutrition. Those who will go in for the entire medical course will thus have another degree to their credit without any additional expense or loss of time. Steps should also be taken to acquaint the lay public with general and fundamental principles of physiology—by lantern lectures, models, charts and pamphlets in different vernaculars. This will promote better health and longer lives for the people.

So physiology should find a leading place in the curricula beginning from the schools up to post-graduate standards.

3. Dr. B. Narayana, Patna.

Physiology should receive much more attention than what it had in the past. The teaching of physiology could be safely divided under several heads, viz. (1) physiology in secondary schools, (2) physiology for the degree course, (3) post-graduate work in physiology, and (4) finally physiology in the medical colleges. It is necessary that physiology should be introduced in the secondary schools preferably as a compulsory subject along with hygiene so that the student might know something about his own body in order to keep himself fit and active. The teaching of physiology for a degree course ought to be introduced in all the principal universities in India and to do that it is necessary that there should be co-ordination between the medical and the science colleges. Just at present there is a lack of co-operation and unless this is removed physiology cannot develop as a purely scientific subject. To my mind the student should be encouraged to study basic subjects like mathematics, physics, chemistry or even biology at the I.Sc. stage but at the B.Sc. stage the student should have the facility of studying physiology as a purely scientific subject if he so wishes. After qualifying as a graduate in physiology, a student should be encouraged to undertake post-graduate studies in the subject. This post-graduate study could be arranged either at the science or at the medical colleges and the student should study not only the advanced physiology but should also be encouraged to take up independent scientific problems for research work. The outlook of a purely science student in physiology is different from that of a medical student and in order that the subject might improve it should find a place in general education on the same lines as the subjects like physics, chemistry and biology. It is necessary that the subject be introduced at the different stages as described above in all the universities in India and it is necessary at the same time to link up the Faculty of Medicine with the Faculty of Science so that a student proceeding to a medical degree may take up a purely science degree in some of the pre-clinical medical subjects before he graduates in medicine. Such a scheme would be more or less in a line with a number of universities in Europe.

4. MR. AFTAB HUSAIN, Hyderabad-Deccan.

Physiology should not only be an integral part of any scheme of normal instruction, but it should be made compulsory in all the schools. We have to remember that the majority of our school-students discontinue their studies after leaving their schools. Therefore it is of great importance to realize that for the sake of the health of a Nation in general, every boy must have a general idea of his body machine. This will only be possible if the subject is made compulsory. We in Hyderabad-Deccan have found that if the subject is treated in a popular manner the school-boys take keen interest in the subject. The importance of physiology in school curriculum cannot be overemphasized. The sooner it is made compulsory in all schools the better.

5. DR. B. L. BHATIA, Lahore.

He supported the demand for a wider recognition of the subject in schools, and explained that in the Punjab, physiology and hygiene can be taken as an optional subject for the Matriculation Examination, and have been studied for the last 25 years, and text-books on the subjects are available not only in English, but in Hindi and Urdu also. The subject of physiology has also been prescribed for the B.Sc. and M.Sc. degrees since the beginning of the century, though it is taught in the medical college and not in the colleges of science. He contended that Professors of Physiology in the medical colleges should be debarred from private practice and devote themselves to investigations in the subject.

The teaching in schools should be entrusted to those who have had a grounding in practical biology. According to Dr. Bhatia, it was a moot point whether physiology should be taught in schools as a separate subject or as a part of elementary biology or general science. In the primary and basic schools, the elements of the subject should be taught to all boys and girls without the teaching being named as physiology.

6. PROF. N. M. BASU, Calcutta.

It is a matter of shame that it has become necessary for us to discuss the question of having a place for physiology in general education. To an ordinary layman physiology used to be and is still unfortunately considered to be a science of frogs, rats, rabbits and cats, but in recent times its widespread applications to various practical questions of dietetics and nutrition which would always arouse an absorbing interest to human beings, to problems of various kinds of anæmia, in the diagnosis of various types of cardiac insufficiency and so on, have succeeded to a considerable extent in impressing the intellectuals in all western countries with the necessity of fostering the growth of this science and introducing it in general education. It is, therefore, in the fitness of things, that we, physiologists of this country, should at this opportune time agitate and try to impress the intellectuals of this country and the Government with the urgent necessity of actively encouraging the growth of this science in this country as well. It has, therefore, become necessary for us to discuss the question of importance of physiology in general education in all its aspects.

Inherent necessity of a man to know his body.

From times immemorial human beings have been always confronted with various queries about his body, such as, where it has come from, how it grows, how to keep it well, how to utilize it to the best advantage for his needs, how to prolong its useful and healthy existence for the longest period possible and so on. As these are amongst the utmost important queries to which answers have been attempted to be given in books on physiology, this science, therefore, created the most primary interest in human beings. It is, moreover, the inherent necessity of a man to know his body. If he does not know the components of the machinery of his body and their functions it is no wonder that he would at every step put it out of gear and would invite troubles. Naturally, therefore, in such circumstances, he seeks the assistance of those who know or pose to know the origin of these troubles and their remedies. He thus, unconsciously, becomes a victim, in the absence of genuine medical men, to witchcraft and persons professing to possess supernatural powers. This is one of the reasons why there has been an unusual influence of so-called *sadhus* over the intellectuals and others of our country.

Its use in domestic hygiene.

The importance of the knowledge of physiology in day-to-day life is too well known. It is a great aid to us in the selection of our foods, in cooking, in attending the sick, in the regulation of our habits, taking care of infants, expectant and lactating mothers, in rendering first aid to the injured, in the prolongation of youthful activities and the prevention of senile decay and so on.

Its use in social service.

If our people were equipped with proper knowledge of this science and if the necessary means for the application of this knowledge were at their disposal, cases of dyspepsia, diabetes, hypertension, ill-formed bodies, etc., would have been rare. Cases of various types of malnutrition caused by the deficiency of intake of one or more dietary essentials which are easily available in cheap vegetables and other foods and cases of nutritional anæmia are found to be widely prevalent amongst rural population. It has been shown that a slight increase in cost in their diet would render selection of such foods possible as would largely help in the banishment of nutritional anæmia and diseases due to malnutrition. The craze for sweets and delicacies prepared from white flour in preference to milk, leafy vegetables and fresh fruits at a lower cost is to be attributed to a vitiated taste, gradually developed amongst the people on account of their ignorance of the basic principles of nutrition. It is again for the same reason that the use of various types of fried rice (such as, 'Muri', 'Khai' and 'Chira' rich in vitamin B, particularly the latter two) has been supplanted by that of biscuits of lower nutritive value. The modern researches have brought to light the importance of skin of various fruits and vegetables, for several dietary essentials in them are most abundant in the skin and diminish gradually towards the interior. Thus the habit of peeling off completely the vegetables and sucking the juice of fruits is to be deplored.

Physiology as a science.

The general run of people have an idea that as physiology is an easy science, its votaries cannot occupy the same pedestral which is meant for those of physics and chemistry. Is this notion based on a correct appreciation of the problems of physiology? Is it not a fact that its various problems have baffled the ingenuity of the greatest masters of science? It is really a pity that the best students are not attracted to this science partly on account of the prevailing above-mentioned ideas. Some of its problems require for their solution the team work of a galaxy of scientists as were engaged in unfolding the mysteries of nuclear physics, such as, the problem of the nerve-impulse, the mechanism of the mediation of the cones in day vision and so on.

Conclusion.

In view of these considerations shall I not be justified in requesting you for the sake of advancement of physiology and for the diffusion of its knowledge amongst the people in general to pass certain resolutions and communicate them to the various Provincial Governments and Universities in order that physiology may be accepted as one of the compulsory subjects in the matriculation course and preferably also in the intermediate course, and further that it is recognized as an independent science, and is accordingly allowed to be taken up as an independent subject in the graduate and post-graduate courses of all the universities in India? If you agree in passing these resolutions, it would be necessary for us to form a committee for framing the syllabus for the various examinations of different universities and suggesting such measures as would improve the teaching of and encourage research work in physiology.

RESOLUTION PASSED UNANIMOUSLY AT THE MEETING AT THE END OF THE DISCUSSION.

This meeting of the Section of Physiology of the Indian Science Congress held at Lahore on the 3rd January, 1939, to discuss the Place of Physiology in General Education, points out that a knowledge of the working of our bodies is essential to all who would attempt in any way to improve the standard of physique of the race. The significance of breathing and its variations, the meaning of the pulse to the heart-beat, the nature and fate of the food we eat and its relations to our development and the work we do, are all subjects of the highest importance to our welfare, yet only a small fraction of us have anything but the slightest conception of their significance. With a view to the wider dissemination of knowledge on these matters this meeting resolves:—

(1) That the teaching of Physiology be introduced in the curriculum of all the secondary schools in India.

(2) That Physiology be taught as an independent subject along with other scientific subjects under the various Universities in India, and that post-graduate teaching in Physiology be also encouraged by these Universities.

(3) That students of Medical Colleges in India be given facilities at the end of their pre-clinical period for appearing at the B.Sc. Examination with one or more of the following subjects, viz. Physiology, Anatomy, Pharmacology, Botany, Zoology, etc.

(4) That it is highly desirable that graduates and under-graduates with Physiology as one of their subjects be given preference for admission to Medical Colleges and Teachers' Training Colleges.

(5) That a central Committee be formed under the auspices of the Science Congress to prepare courses of recommended study

for the various stages of the teaching of Physiology and that a copy of these resolutions be sent to the Directors of Public Instructions and the various Provincial Governments and the Vice-Chancellors of the different Universities in India.

PERSONNEL OF THE COMMITTEE FORMED AT THE MEETING.

Dr. B. Narayana	Bihar.
Dr. W. Burridge	U.P.
Col. S. L. Bhatia, I.M.S.	Bombay.
Drs. B. T. Krishnan, T. S. Tirumurthi, and M. A. Basir	Madras Presidency.
Dr. S. A. Rahman	Hyderabad.
Dr. Subba Rao	Mysore.
Drs. B. L. Bhatia and K. S. Grewal	Punjab.
Col. R. N. Chopra, Prof. N. M. Basu, Dr. S. P. Mookerjee and Dr. B. Mukerji	Bengal.

Dr. Syamaprasad Mookerjee	*President.*
Prof. N. M. Basu	*Secretary.*
Dr. B. Mukerji	*Asst. Secretary.*

XV. PSYCHOLOGY IN THE SERVICE OF EDUCATION IN INDIA.

(*Section of Psychology.*)

MR. H. P. MAITI, Calcutta, presided and opened the discussion.

Opening Remarks.

In his opening remarks the President said that education is an art, very different from the theories of the Psychologists. Most of the teacher-pupils, after receiving their training in Psychology, left their knowledge behind. This cannot be cured by giving them a bigger dose of Psychology. It would be more advisable to have a trained Psychologist for each school, or if this was impracticable for the present to have expert Psychologists to advise provincial educational authorities on educational problems.

2. MR. W. M. RYBURN, Kharar.

He led the discussion by mentioning here some ways in which Psychology and Psychologists can help education and schools in this land. Opinions will vary as to the practicability of some of these suggestions, but it is of great advantage to have a definite ideal before us for which we may work stage by stage. In certain fields, work is already being carried on, but in others nothing has yet been done.

(1) *Intelligence Test :—*

There is a definite need for group tests in different language areas. In the Punjab Dr. Rice's adaptation of Terman Test is quite good for the school population, but we want also a non-verbal test suitable for illiterates and for quicker application.

(2) *Attainment Test :—*

We need properly standardized attainment tests in different school subjects. Tests in reading will have to be done separately for each language area.

(3) *Vocational Test :—*

Vocational tests, as used elsewhere, should be adapted to Indian conditions and applied by trained Psychologists.

(4) *Help in understanding the child :—*

We have here a field where a great deal of help can be given to teachers and parents. All of us who are dealing daily with children need expert advice as to how to deal with the 'difficult' child, the fear-filled child, the child who steals, the child with the inferiority complex, and so on. We need definite psychological research as to how far methods of dealing with such children, used in the West, would prove useful in Indian conditions of life. This research is necessary in view of the fact that environment, heredity and training are different in India and in the West.

(5) *Child Treatment Clinics :—*

We should have a large number of these clinics. The clinics would be a source of spread of valuable knowledge on mental hygiene for teachers and parents. If for financial difficulty we may not have many clinics for the present, we should have trained Psychologists who would go about visiting schools in particular areas.

(6) *Study of the psychological characteristics of Indian children :—*

A great deal has been done on this line in the West, but comparatively little in India. We want to have some definite knowledge of what to expect from normal Indian children at different ages. The study necessary for this knowledge may have to be done on a provincial basis.

(7) *The effect of social and economic environment on psychological growth and development :—*

Research on this question is very much important, otherwise in seeking to improve the individual by changing his environment we are working in the dark.

(8) *Psychological approach to teaching method :—*

Method is the most important part of teaching. Use of Psychology in education should concentrate on the suggestion and improvement of method. We need to know when certain operations in Arithmetic can best be taught, suitable types of games for different ages, best way of teaching reading, how to develop creative work, etc.

3. Mr. R. R. Kumria, Lahore.

He deplored the absence of a scientific and objective attitude. He referred to the absence of Psychology in the S.A.V. course, and suggested that the teacher should be made psychology-minded. The study of the dynamic unconscious and sex education must be included in the training courses. The study of socio-economic factors was also very important.

Teachers-in-training should have a thorough grounding in Psychology. The Psychology curriculum for them should stress the following heads: 1. The child mind with its various abnormalities. 2. The adult mind in the teaching situation. 3. Administration of Intelligence Tests; Studies of abnormal children and principles of Child guidance.

4. Mr. K. L. Shrimali, Udaipur.

He referred to the relation between psychoanalysis and education.

The services which psychoanalysis can render to education are :

(1) Psychoanalysis can help the teacher in understanding his own emotional problems.

(2) The theories of education themselves may be motivated by unconscious factors and they may be tested at the touchstone of psychoanalysis.

(3) It can help the teacher in understanding the deeper emotional problems of the child.

The speaker gave concrete examples from his experience.

5. Mr. J. M. Sen, Krishnagar.

He mentioned the effect of socio-economic factors on the development of the child. We know that the boarding school atmosphere is different from the home atmosphere. Our faith in orphanages, reformatories and borstal institutions is an unconscious admission of the influence of the social environment. From the results produced by such institutions it is clear that even hooligan children may be made good citizens.

6. Dr. I. Latif, Lahore.

He referred to the present-day neglect of the emotional life of school children. Emotional education should start at the earliest period of infancy. He referred to the genesis of emotions in close relation to the various organic functions of the child. He stressed starting of centres for the training of parents to avoid arrested emotional development in the next generation.

7. Dr. Indra Sen, Delhi.

He stressed the advantage of the 'cultural psychology' point of view, and also of the characterological approach. After referring to the administrative aspects of education he suggested that Psychology could offer solution to many problems of education.

8. Mr. Parsram, Lahore.

He opined that Psychology cannot satisfy common human desires but gives an insight into our character, and can help us to change desires and outlook upon life. This is the real service of modern Psychology. Psychoanalysis has pointed out the injurious effect of heightened will-tension on character and has an important bearing on future education. Educators should try as a rule to avoid excessive will-tension in pupils.

9. Mr. U. S. Gheba, Delhi.

He discussed a case of bad memory from his own clinical experience. There was a wonderful improvement in the class examination of the child after a short course of psychoanalysis.

10. Mr. A. E. Foot, Dehra Dun.

He gave examples from his experience at Eton as to how Psychology can help the teacher in understanding mental mal-adjustments in children. The withering tongue of a colleague does considerable harm. He stressed that the unthinking schoolmaster may create acute sense of vanity in some of his pupils.

11. DR. P. RAZDON, Benares.

He discussed the suppression, repression, frustration and sublimation of instincts. The ideal of *brahmacharya* was, according to him, an excellent method for the modification of human instincts.

12. MR. S. BHAN, Lahore.

He discussed discipline in schools from the point of view of New Education movement.

13. MR. G. C. CHATTERJI, Lahore.

He stated that the immediate need was to bring the Psychologist into contact with concrete school problems. He proposed the formation of a committee to make a preliminary survey of the situation in India. This suggestion was approved and a strong committee was nominated with Mr. H. P. Maiti as the convener.

XVI. FACTORS DETERMINING CHANGES IN RELIGIOUS PHENOMENA.

(*Sections of Psychology and Anthropology.*)

MR. H. P. MAITI, Calcutta, presided.

Opening Remarks.

Prof. H. P. Maiti introduced the debate by referring to the importance of the scientific study of religion. He said that the need for a scientific outlook about religion is at present very great in the world, and specially so in India. India has been said to be the 'home' of religion, but we know how communal differences and clashes have exploited religion in recent times. India is, again, a 'subject' country, and religion is very likely to afford an easy compensation for what she has lost in the political sphere. Prof. Maiti hoped that scientific approach to religion will help India in her work of political and social progress.

2. DR. N. N. SENGUPTA, Lucknow University.

He opened the debate with an analysis of the basic constituents of religion. Religion is a complex pattern of a number of factors, subjective and objective. If we symbolize subjective factors by S, behaviour by B, and objective factors by O, religion can be symbolically represented in two different ways; S—B—O and O—B—S. The S factors can be divided into two groups. Ecstasy, insight and devotional feeling have no reference to external objects and form the first group. Beliefs, theories and visions refer to external world, and form the second group. In the first type of religion represented by S—B—O, religious behaviour is started by S factors and is directed outward to religious objects. In the second type of religion represented by O—B—S, behaviour is induced by objective factors and brings about change in subjective processes, first in emotions and attitudes, and then in beliefs and theories.

Religion is social when ecstasy, insight and feeling are directly brought into relation with beliefs, behaviour and objective factors. It is personal when these are comparatively stressed and the rest of the factors become secondary.

Religious phenomena appear in five different configurations: (1) that of ecstasy, insight and devotional feeling; (2) that of emotions and attitudes; (3) that of beliefs, theories and visions; (4) that of behaviour;

(5) that of object-situations. These five configurations may enter with each other into different degrees of interlacing, some religions being more integrated, and some being less.

Religious change can be brought about by:

(1) Dissociation of the constituent configurations of religion.

(2) Relative stressing of one or other of these constituents (this is illustrated in change of mysticism into ritualism and *vice versa.* The former stresses ecstasy and insight, and the latter symbols and rituals).

(3) One of the constituents undergoing a marked alteration. Historically the factors that have undergone such alteration are:—

(i) *Insight.* (ii) *Emotion.* (iii) *Belief.*

(i) The difference between the Sanker and the Ramanuj cults in South India relates to the insight factors. Ecstasy and insight imply a personality and hence the rise of a great personality with these traits has been the most important factor of religious change. (ii) Revivalism illustrates in its different forms the value of the emotional factor in bringing about religious change. Sense of sin and helplessness and feelings of exaltation have usually inspired revivalism. (iii) Religious beliefs are profoundly changed by contact with other groups and their culture.

(4) Change in subjective factors not being attended by corresponding change in religious behaviour. The latter is subject to the law of habit and has been responsible for religious conservatism.

(5) Change of the material setting of religion, e.g., holy places, images, rites, etc., due either to iconoclastic zeal of the reformer or to accidental causes.

In other words, religious phenomena exhibit a tendency to polarity. Religion of a cultural society is neither pure ritualism nor pure mysticism, but moves usually between these two poles. Religious change may begin on the personal plane, and percolate to outward forms under pressure of crisis in the psychic history of the individual. This is found in conversion. Under suitable social condition a personal religious crisis may also precipitate a crisis in social religion, as in mass conversion. Religious change may, on the other hand, begin on the social plane and percolate into subjective religious experiences of individuals. Such changes are initiated by changes in objective factors, e.g., rise of a great personality, stress on holy places, or mythical events, growth of religious literature, growth of ceremonial worship, etc. Where religious change is due to change in objective factors, the whole group life is affected by it.

Beliefs and theories alter due to the impact of rival views, but this alteration has to be supported by inner changes in the personality trends of the individual affected. Religious change arises through the confluence of several factors acting on the life of the individual living in the midst of a particular tradition and exposed to new cultural pattern. These factors are the influence of his own group and its tradition, the influence of the alien culture pattern and the influence of his own unconscious trends. The process of religious change thus raises no new problem for the Psychologist. It occurs through the coalescence of factors that ordinarily determine change in the course of mental life and behaviour.

By way of conclusion, Prof. Sengupta observed that religious change is the outcome of currents and cross-currents of psychological, social and historical trends. It is not yet known, however, whether the sum total of the changes corresponds to the sum total of causes.

3. PROF. K. P. CHATTOPADHYAY, Calcutta.

He referred to some examples of primitive religion to show that religion has always a social and a personal aspect. Religions begin in a vision or personal experience and grow when others share in the experience to some extent and spread the personal cult. The rank and file are attracted by hopes of fulfilment of worldly aspirations or perform the religious routine because of the necessity of conforming to the social pattern. With change in economic and social environment, the vital necessity that had led to the origin of the cult may disappear and the cult itself may also disappear leaving only vestigial traces. The innate impulses from which religion arises do not change. What changes with time is the outward setting of the impulses. The most important impulse which, according to Prof. Chattopadhyay, underlies religion is the feeling of utter helplessness in the face of the natural phenomena of death. To it is directly traceable the growth of animism on the intellectual side, and of the peculiar religious attitudes of fear, awe and tenderness to some great power on the emotional side.

4. DR. D. N. MAJUMDAR, Lucknow.

He described how social life in primitive society was vitally connected with religious beliefs and practices and how social disorganization and disintregation had led to change in religious belief among primitive tribes. He gave examples how primitive people associated their dream/experiences to real happenings. Thus when the Mundas or Hos dream a Mahomedan administrator, a peon or itinerant vendor, they believe that their Bongas or Spirits were offended and sacrifices and propitiation followed such dreams. It was, Dr. Majumdar pointed out, not an accidental relation that they recognized between their dreams and the consequences they envisaged but was engendered by a habitual process of thought which attributed all their miseries to alien influence and alien exploitation. Dr. Majumdar remarked that so long the psychological approach to the study of culture was not very successful in interpreting the culture data, as the Psychologists depended on the data collected by the Anthropologists. The time has come when Psychologists should come out of their laboratory and take part in field investigations collaborating with Anthropologists so that many of our gaps in the knowledge of primitive life may be bridged over.

5. PROF. H. D. BHATTACHARYA, Dacca.

He gave a review of the methods followed by the various participants and pointed out that unless emphasis was laid on both subjective and objective aspects, mere interpretation from the behaviouristic point of view would not explain the determinants of religious change.

6. PROF. BAHADUR MAL, Lahore.

He spoke on the influence of unconscious factors on religious phenomena. Religion is essentially a basic craving of the human mind for complete and unlimited security. Religious phenomena are instrumental in bringing about satisfaction of this craving. Important factors responsible for religious changes are: (1) creative urge, (2) priests bringing about gradual changes, (3) spiritualpersonality, (4) growth of scientific knowledge, (5) culture contacts, (6) politico-economical changes. There is a tendency for shifting of emphasis from objective to subjective aspects of religion with growth of culture.

Dr. N. N. Sengupta made a suitable reply and said that though he had dwelt more on the objective factors of religious changes, he had not lost sight of the subjective factors. He agreed with Dr. Majumdar that Psychologists had not been of much help to Anthropologists and pleaded for greater co-operation.

The President summed up the debate and expressed satisfaction at the high level of the discussion in the symposium. He assured the Anthropologists more practical help in future from the side of Psychologists in India.

LIST OF MEMBERS, TWENTY-SIXTH INDIAN SCIENCE CONGRESS.

ORDINARY MEMBERS, 1938-1939.

As at the close of July 15*th*, 1938; *Rule* 4.

The names of Life Members are marked with an asterisk.

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INDEX.

[*A Roman numeral has been prefixed to the Arabic page number. These Roman numerals indicate the parts which each have their independent page numbering in Arabic numerals.*]

A

Abdussalam, M. On a new feather mite Paraphagistic on the Indian domestic fowl (*Gallus bankiva murghi*), IV, 8.
Abdussalam, M. On a new trombidiid larva parasitic on the house rat (*Rattus rattus* Var.), III, 173.
Abdussalam, M. On a new Trombidiid larva parasitic on the house rat (*Rattus rattus* Var.), III, 141.
Abdussalam, M. The occurrence of equine nasal bot, *Rhinœstrus purpureus* (Brauer, 1858) in India, IV, 8.
Abichandani, C. T., and S. K. K. Jatkar. Dissociation constants of catechol, resorcinol, hydroquinone, pyrogallol and phloroglucinol, III, 48.
Abichandani, C. T., and S. K. K. Jatkar. Dissociation constants of hydroxy-benzoic acids and gallic acid, III, 48.
Abichandani, C. T., and S. K. K. Jatkar. Molybdenum electrode, III, 47.
Absorption from binary mixtures, III, 56.
Absorption of active-nitrogen in the Schumann region, III, 22.
Absorption of bismuth vapour between 600 Å and 900Å, III, 21.
Absorption of the dyestuffs in solution—On the influence of foreign substances on the, III, 29.
Absorption spectra of single crystals of Rare Earth Salts under polarised light—The, IV, 1.
Absorption spectrum of cadmium by the excitation of inner electrons, III, 21.
Accounts—Statement of, I, 49.
Acculturation—Symbiosis and, II, 218.
Acculturation—Tribal cultures and, II, 179.
Acharya, B. G. S., and T. S. Wheeler. Studies in 2-naphthyl chromones, III, 63.
Acharya, B. M. *See* Chatterjee, S. P., and B. M. Acharya.
Acharya, (Dr.) C. N., IV, 41.
Achromatic objective—The making of a 6″ long focus (15′), IV, 4.
Acridine derivatives. Part II, III, 64.
Action of drugs on the coronary flow, III, 215.
Active nitrogen—Studies in. Part II, III, 41.
,, ,, Part III, III, 42.
,, ,, Part IV, III, 42.
Adhya, P. C. *See* Ghosh, B. N., and P. C. Adhya.
Adsorbent charcoal as determined by different methods—The relative activities of samples of, III, 49.
Adsorption and retention of helium by cocoanut shell charcoal, III, 49.
Aeroplane soundings with meteorograph over Karachi—Experimental, III, 17.
Aesthetic value—An experiment on, III, 221.
Agarwalla, D., and M. Samanta. Application of Dearborn Formboard tests, III, 226.
Aggarwal, J. S. *See* Chowdhury, H. D., S. N. Mukerji, A. N. Kapoor, and J. S. Aggarwal; also Karimullah, N. Ghatak, J. S. Aggarwal, and Lal C. Verman.

Agricultural cycle—The, IV, 19.
Agricultural Meteorology, III, 200.
Agriculture in India—Some insect problems connected with, II, 288.
Agriculture—Section of, II, 271; III, 181.
Agronomy, III, 181.
Ahmad, N., and A. N. Gulati. The effect of storage at different relative humidities on the strength and colour of cotton, III, 29.
Ahmad, N. *See* Gulati, A. N., and N. Ahmad; also Sukthankar, S. S., N. Ahmad, and H. Nawkal.
Ahmad, Nazir. Fishes of Karachi, III, 135.
Ahmad, Nazir, R. D. Desai, and G. S. Sahariya. Studies in the naphthalene series. Part IV. Synthesis of trans-decahydronaphthalene-2-carboxy-3-acetic acid, III, 62.
Ahmad, Taskhir. The life-history and morphology of *Euderus livida* (Ashmead) a larval parasite of the tur-pod fly, *Agromyza obtusa*, III, 140.
Ahmad, Taskhir, and R. L. Gupta. The pea leaf miner, *Phytomyza atricornis* meig. in India, III, 193.
Air layers near the ground at night during clear weather in relation to other meteorological factors—The thermal structure of the, III, 19.
Airan, J. I., and S. V. Shah. A study of Kolhapur waters from different sources, III, 101.
Aiyar, R. Gopala, and (Miss) G. Mahadevan. On a collection of elasmobranch embryos obtained from the Madras coast, III, 134.
Alam, Nek. *See* Singh, Darshan, and Nek Alam.
Alawi, A. H. Jameel. Psychological aspects of some customs of the Sansi tribe, III, 231.
Alexandria—Post-Hippocratic medicine of, II, 240.
Algebraic identity and a unit recurrent—On an, III, 5.
Ali Ashraff. *See* Desai, R. D., Ashraff Ali, and H. P. Shroff.
Alimchandani, R. L. *See* Dharwarkar, H. V., and R. L. Alimchandani; also Kulkarni, D. R., N. M. Shah, and R. L. Alimchandani.
Alimentation and metabolism, II, 326.
Alphos or sugarcane grown in an acid soil—Effects of, III, 186.
Alvi, F. R. M. *See* Puri, V. S., and F. R. M. Alvi.
Amad, K. Formation of false growth rings in chir pine (*Pinus longifolia*, Roxb.) and its relation to growth factors, III, 124.
Amin, Mohammad. Discussion on the validity of *Moniezia denticulata* (Rudolphi, 1810) (= *alba* Perroncito, 1879) Blanchard, 1891, III, 130.
Amin, Mohammad. On a new variety of *Avitellina sudenea* (Cestoda) with a note on the anomaly in its genitalia, III, 131.
Anæmia of pregnancy—Further studies in the Biochemistry of, III, 161.
Analogy among chemical elements and radicles, II, 45.
Anand, B. M., and Narain Singh. Raman spectra of camphor in different solvents, III, 27.
Anand, B. M. Production of hydrogen Lyman series, III, 22.
Anand, B. M. *See* Kichlu, P. K., and B. M. Anand; also Ram, Mela, P. N. Kalia, and B. M. Anand.
Anantakrishnan, S. V., and T. N. Krishnamurthi. Studies in the hydrolysis of esters. Part I, III, 47.
Anantakrishnan, S. V. *See* Karim, S. Mujtaba, Lal C. Verman and S. V. Anantakrishnan; also Saboor, M. A., S. V. Anantakrishnan, and Lal C. Verman.
Anantanarayanan, K. P. *See* Cherian, M. C. and K..P. Anantanarayanan.
Anantaraman, M. The development of *Temnopleurus to reumaticus* (Klein), III, 131.
Anatomy—A Brief history of pathological, II, 247.
Anatomy, III, 216.
Ancient Hindu Medical Sciences, II, 231.
Anger in children—A study of, III, 232.

Angiosperms. (i) Morphology, III, 120.
Angiosperms. (ii) Anatomy, III, 124.
Angular distributions of emitted particles in nuclear reactions, III, 12.
Annamalai, D. R. *See* Seshadrinathan, N., and D. R. Annamalai.
Anopheles sundaiens Rodenov—Breeding habits of, IV, 6.
Anthropological Research—Application of Statistical Methods in, IV, 22.
Anthropology—Section of, II, 179; III, 149.
Aphosphoresis with contagious equine abortion—The association of, III, 180.
Applied Mathematics and Statics, III, 6.
Archæological and Anthropological Research in India—Scope of Private Enterprise in, IV, 20.
Arhynchobdellid leech, *Hæmopis sp.* from Kashmir (India)—An, IV, 6.
Aslam, M. Religious experiences of Muhammad, III, 229.
Association in formic acid, III, 27.
Astronomy, Astrophysics and Atomic Physics, III, 10.
Asundi, R. K., and Asrar Husain. Predissociation in the bands of CuCl, III, 22.
Asundi, R. K., and M. M. Aziz. The flame spectrum of copper bromide, III, 23.
Athavale, V. T., and S. K. K. Jatkar. Chromium chromates, III, 37.
Athavale, V. T., and S. K. K. Jatkar. Isomerization of oleic acid by nickel catalyst, III, 70.
Athavale, V. T. *See* Joglekar, R. V., V. T. Athavale, and S. K. K. Jatkar.
Atmosphere—The Earth's Magnetism and the Upper, II, 19.
Atmospheric strata—A study of stability of, III, 16.
Auluck, F. C. The Internal constitution of white dwarf stars and the planets, III, 13.
Auluck, F. C. Entropy of Fermi-Dirac gas, III, 13.
Ayyangar, G. N. Rangaswami. Ipomoea hispida, Roem and Sch., a useful fodder weed, III, 182.
Ayyar, N. K. *See* Sen, K. C., and N. K. Ayyar.
Ayyar, (Mr.) P. N. Krishna, IV, 27.
Ayyar, P. N. Krishna, and V. Margabandhu. The rôle of food and its constituents on the productivity and longevity of the cotton stem weevil (Pempheres offinis F S.T.) of South India, III, 192.
Ayyar, (Dr.) T. V. R., IV, 20, 27, 41.
Ayyar, (Dr.) T. V. Ramakrishna, IV, 33.
Ayyar, Rao Sahib T. V. Ramakrishna, III, 181.
Ayyar, Rao Sahib T. V. Ramakrishna. Insects and their rôle in Indian Agriculture, II, 271.
Ayyar, T. V. Ramakrishna. Some hairy caterpillar pests of S. India, III, 196.
Ayyar, T. V. Ramakrishna. Some non-insect pests and insectivorous animals of agricultural importance in S. India, III, 192.
Aziz, M. M. *See* Asundi, R. K., and M. M. Aziz.
Azolla pinnata, R.BR.—Some ecological observations on the life history of, III, 126.

B

Babesia foliata, n.sp. from a sheep—Observations of, III, 171.
Bacteriology, III, 162, 172.
Bacteriology—The History of, II, 255.
Bacteriophage and candle filtration, III, 163.
Bagchee, K. D. Indian Forest Mycology with special reference to forest pathology, II, 141.
Bagchee, Krishnadas, III, 115.
Bagchi, B. K. Brain potential rhythm and levels of sleep, III, 203.
Bagchi, B. K. Electrical rhythm from the intact human brain, III, 233.

Bagchi, K. N., H. C. Chakravarti, and H. D. Ganguli. Fatal poisoning by paranitraniline, III, 166.

Bagchi, K. N., H. D. Ganguly, and J. N. Sirdar. Lead in human hair, III, 209.

Bagchi, K. N., H. D. Ganguli, and P. N. Mukherjee. Studies on toxicology of *Execaria agallocha* and difficulties in the way of medico-legal investigations, III, 167.

Bagchi, N. C. Behaviouristic peculiarity of feeble-minded children, III, 233.

Bagchi, P. N. *See* Rây, P. R., and P. N. Bagchi.

Banerjea, H. N., L. A. Bhatt, and R. B. Forster. A new method of estimating hydrogen by absorption in technical gas analysis, III, 99.

Banerjee, (Mr.) A. K., IV, 17.

Banerjee, A. K. Markets of Calcutta, III, 109.

Banerjee, B. N. *See* Ramasarma, G. B., and B. N. Banerjee ; also Sabnis, C. V., and B. N. Banerjee.

Banerjee, H. C., D. N. Roy, and T. P. Bhowmik. Group tests of intelligence for Bengali scholars (Class V–Class X), III, 225.

Banerjee, H. C. Reliability of repeated grading of English essays, III, 226.

Banerji, A. C., and P. L. Bhatnagar. On the intensity of the ionization of the earth's atmosphere, III, 14.

Banerji, A. C., Nazimuddin, and P. L. Bhatnagar. The arms of a spiral nebula, III, 11.

Banerji, A. D., C. A. Khan, and Lal C. Verman. Use of Indian bentonite in building materials, III, 31.

Banerji, A. K. *See* Bhaduri, J. L., and A. K. Banerji.

Banerji, M. N. Problems and difficulties of Vocational guidance, III, 225.

Banerji, P. C., and K. Raghavachari. A clinial investigation into the etiology of rickets in pups of an indigenous Indian breed, III, 170.

Banerji, S. K. Relationship between upper wind velocity and temperature, III, 15.

Barpujari, G. N. *See* Chatterjee, N. N., and G. N. Barpujari.

Basak, M. N. *See* Basu, K. P., M. N. Basak, and B. Raychowdhury ; also Basu, K. P., M. N. Basak, and M. K. Haldar.

Basheer, Mohamed. *See* Cherian, M. C., and Mohamed Basheer.

Bastar Estate—Descriptive account of, II, 182.

Basu, K. P., M. N. Basak, and B. Raychowdhury. Metabolism of calcium and phosphorus in human beings, III, 211.

Basu, K. P., M. N. Basak, and M. K. Haldar. Endogenous protein metabolism of man and the distribution of sulphur in human urine on non-protein diet and on diets containing different amount of proteins of rice and whole wheat (Atta), III, 210.

Basu, M. N. *See* Basu, R. N., and M. N. Basu.

Basu, N. M., III, 203.

Basu, (Prof.) N. M., IV, 46, 49.

Basu, N. M., and G. K. Ray. A preliminary note on the relationship between the copper content and the ascorbic-acid-oxidose activity of the different protein fractions separated from the drumstick juice, III, 207.

Basu, N. M., and G. K. Ray. Observations on the minimum requirements of Vitamin C of Bengali boys, III, 213.

Basu, N. M., and G. K. Ray. Observations on the state of saturation of Bengalee boys with regard to Vitamin C, III, 212.

Basu, N. M. Physiological research in India, II, 317.

Basu, R. N. A plea for the reconsideration of the anatomical landmarks in craniometry, III, 149.

Basu, R. N., and M. N. Basu. The Pterion in Indian human crania, III, 150.

Basu, U. P., and A. Majumder. On the stability of oils, III, 74.

Basu, U. P., and H. Goswami. On the ferrous iron content of Indian soils, III, 186.

Basu, U. P., and P. Das Gupta. On 2-phenyl-4-amino-quinoline derivatives, III, 74.

Basu, U. P. Diet in requirements of copper for infants, III, 166.

Basu, U. P. On the activity of liver concentrate, III, 214.

Batrachians and their environment, II, 169.

Bawa, H. S. Rinderpest in sheep and goats, III, 178.

Beggars—The psychology of the III, 231.

Behaviour of nitrogen peroxide under electric discharge. Anomalous pressure reversal effect, III, 39.

Bentonite in building materials—Use of Indian, III, 31.

Beri, M. L. *See* Sarin, J. L., and M. L. Beri.

Bessel functions and Weber's parabolic cylinder functions—Some infinite series involving the product of, III, 2.

Bessel functions—On certain expansions involving, III, 3.

Bhadauria, B. S. Geology of the chromite deposit of Jojohatu, Singhbhum, III, 104.

Bhaduri, J. L., and A. K. Banerji. On the urino-genital and Müllerian ducts in the male of the common Indian toad *Bufo melanostictus*, III, 136.

Bhagavantam, (Prof.) S., IV, 13.

Bhagwat, N. A., and T. S. Wheeler. Reactivity of aryl-*o*-alkoxystyryl ketone dibromides, III, 75.

Bhalerao, G. D. A brief survey of the development of the knowledge of Trematode fauna of India, III, 130.

Bhalerao, G. D. A new unusual helminths of some domestic animals in India, III, 175.

Bhalerao, G. D. Observations on the anatomy of *Acanthostoma* buminis (Bhalerao, 1928), III, 130.

Bhan, (Mr.) S., IV, 55.

Bharucha (Dr.) F. R., IV, 33.

Bhaskar, T. D. *See* Joshi, S. S., and T. D. Bhaskar.

Bhat, R. V., R. B. Forster, and K. Venkataraman. Studies in the naphthol A.S. Series. Part III. Synthetical experiments, I, III, 71.

Bhatia, A. C. The psychology of the beggars, III, 231.

Bhatia, (Dr.) B. L., IV, 49.

Bhatia, D. The locust (*Schistocera*) with reference to Sind and Rajputana desert plants, III, 191.

Bhatia, M. L. An Arhynchobdellid Leech, *Hæmopis sp.* from Kashmir (India), IV, 6.

Bhatia, M. L. Glossiphonia reticulata, from the mantle of Lamellidens, the common freshwater mussel of Lucknow, IV, 7.

Bhatnagar, P. L. *See* Banerji, A. C., Nazimuddin, and P. L. Bhatnagar; also Banerji, A. C., and P. L. Bhatnagar.

Bhatnagar, S. S., Brahm Prakash, and Abdul Hamid. Magnetism and molecular constitution of some chromium compounds, III, 43.

Bhatnagar, S. S., P. L. Kapur, and A. Hussain. Studies in bivalent metallic soap, III, 51.

Bhatnagar, S. S., P. L. Kapur, and M. S. Hashmi. Phototropy and photochemical isomerism from the magnetic standpoint, III, 54.

Bhatt, L. A. *See* Banerjea, H. N., L. A. Bhatt, and R. B. Forster.

Bhattacharya, G. N., and H. K. Sen. Dioxane as a cryscopic solvent for shellac, III, 100.

Bhattacharya, G. N., and S. Ranganathan. The effect of ageing on the viscosity of shellac-mea solutions in alcohol, III, 58.

Bhattacharya, G. N. On the specific heat of lac, III, 34.

Bhattacharya, H. *See* Rây, P. R., and H. Bhattacharya.

Bhattacharya, (Prof.) H. D., IV, 57.

Bhavani, G. D. *See* Mulay, B. N., and G. D. Bhavani.

Bhawalkar, D. R. The maximum efficiency of tungsten filament electric lamps, III, 32.

Bhowmik, T. P. *See* Banerjee, H. C., D. N. Roy, and T. P. Bhowmik.

Biguanide with bivalent metals, copper-biguanidine and its salts—Compounds of, III, 37.
Biguanide with tervalent metals, cobalt phenyl-biguanidine and its salts—Complex compounds of, III, 37.
Biochemistry, III, 94, 176, 206.
Biochemistry of Anæmia of pregnancy—Further studies in the, III, 161.
Biswas, P. C. Studies on the hand-form of the Bengalis, III, 149.
Biswas, P. The effects of some ions on the action of Urea-stibamine on frog's heart, III, 216.
Blending and swelling properties of some Jharia coals—Experiments on, IV, 5.
Blood chemistry of normal and hæmaturia animals, III, 180.
Blood—Nonprotein nitrogenous constituents of, III, 208.
Bose, A. *See* Krishnan, K. S., A. Mookerji, and A. Bose.
Bose, G., and D. Ganguly. Psychological study of language, III, 221.
Bose, J. K. Effect of culture-contact on the Garos of Assam, III, 155.
Bose, P. K. On the constitution of tambulin, III, 71.
Bose, (Mr.) R. C., IV, 16.
Bose, (Mr.) R. C., and (Mr.) K. Kishen, IV, 16.
Bose, R. C., and K. Kishen. On the generalized interaction in a $s \times s \times s \times \ldots\ldots\ (= s^n)$ factorial arrangement, where s is a prime or a power of a prime, III, 9.
Bose, (Mr.) R. C., and (Mr.) S. N. Ray, IV, 16.
Bose, R. C., and S. N. Roy. The distribution of the studentised D^2 statistic appropriate to any pair out of a given set of k equidispersional populations distinct in sets of means, III, 7.
Bose, R. C. On the completely orthogonalized Hyper-Græco Latin Square, III, 8.
Bose, S. K. Matching method in the study of personality, III. 226.
Bose, S. K. The 'Social-Affective' concept of meaning, III, 223.
Bose, (Prof.) S. N., IV, 14.
Bose, S. R. An abnormal sterile form of *Polystictus sanguineus* Linn., III, 116.
Botany—Agricultural, III, 187.
Botany—Section of, II, 141; III, 115.
Brahmaputra—The source of the, III, 112.
Bryophyta, III, 119.
Burridge, W. Human temperaments, III, 233.

C

Calcium chlorate from aqueous calcium chloride by electrolysis—Electrolytic formation of, III, 40.
Calcutta—Markets of, III, 109.
Caldwell, Victor. *See* Joshi, S. S., and Victor Caldwell.
Calorie requirements of South Indian Children, III, 164.
Carane—Synthesis of, III, 79.
Cardiac pain, its relation to sudden death and its anatomical basis—Psychology of, III, 233.
Caste and credit in rural society, III, 155.
Casuarina plant—Geography of the, III, 114.
Caterpillar pest of grasses in S. India (*Cirphis albistigma*)—A, III, 195.
Caterpillar pest of moringa in S. India (*Noorda moringæ* T)—A new, III, 195.
Cell-testing device—Automatic, III, 31.
Cereal phosphorus and calcium for rats—The availability of, III, 165.
Cereals and its effect on nutrition—Insoluble ash of, III, 164.
Chairman, I, 12.
Chakrabarti, S. C. On a pair of factorable recurrents, III, 4.
Chakrabarti, S. C. On an Algebraic identity and a unit recurrent, III, 5.
Chakravarti, D., and B. Majumdar. The influence of halogen atom on Kostanecki's reaction in the formation of α- and γ-pyrones, III, 65.

Chakravarti, D., and J. Dutt. Synthetical experiments in the pyrone series: attempted oxidation of chromanones with selenium dioxide, III, 65.
Chakravarti, D., and N. Chakravarti. Synthesis of Coumarino-coumarin, coumarino-chromone and chromono-chromone derivatives, III, 66.
Chakravarti, D., and N. Dutt. Synthesis of coumarins from *o*-hydroxy-aryl alkyl ketones, III, 65.
Chakravarti, D. C. The absorption spectra of Single Crystals of Rare Earth Salts under Polarised light, IV, 1.
Chakravarti, H. C. *See* Bagchi, K. N., H. C. Chakravarti, and H. D. Ganguli.
Chakravarti, N. *See* Chakravarti, D., and N. Chakravarti.
Chakravarti, S. C. *See* Nair, K. R., S. C. Chakravarti, and P. C. Mahalanobis.
Chakravarty, A. New Psychology and its effect on creative literature, IV, 10.
Chakravarty, B. C. *See* Chatterjee, N. N., and B. C. Chakravarty.
Chakravarty, G. K. On the nematode *Camallanus anabantis* Pearse, III, 131.
Chakravarty, M. On a new gregarine from the intestine of the Indian centipede—*Cormocephalus dentipes* Poc, III, 129.
Chakravarty, S. *See* Mitra, R. P., and S. Chakravarty.
Chand, Tara. *See* Ram, Tirath, and Tara Chand.
Chandrakant, L. S. *See* Joshi, S. S., and L. S. Chandrakant.
Charnockites—On the origin of the, III, 106.
Chatterjee, B. The interaction of Silicic acid sol with concentrated alkalis, III, 52.
Chatterjee, C. D. Totemism in Ancient India, III, 152.
Chatterjee, H. N., and J. K. Sarkar. Studies in the histo-pathology of the endocrine glands and the pathology of some other organs and tissues in cholera, III, 161.
Chatterjee, H. N., and S. M. Ghosh. Further studies in the biochemistry of Anæmia of pregnancy, III, 161.
Chatterjee, H. N. Studies in the pathology of the gastro-intestinal tract in cholera, III, 161.
Chatterjee, H. N. Studies in the pathology of hæmolymph organs in cholera, III, 160.
Chatterjee, N. N., and B. C. Chakravarty. Experiments on blending and swelling properties of some Jharia coals, IV, 5.
Chatterjee, N. N., and G. N. Barpujari. Synthesis of pyrene, III, 79.
Chatterjee, Sibsankar. *See* Goswami, M. N., and Sibsankar Chatterjee.
Chatterjee, (Dr.) S. P., IV, 16.
Chatterjee, S. P., and B. M. Acharya. Geography of the town of Krishnagar, Bengal, III, 109.
Chatterjee, S. P. Geography of Puri and adjoining areas, Orissa, III, 109.
Chatterjee, S. P. Gneissic topography of Ranchi Plateau, Chota Nagpur, III, 109.
Chatterjee, S. P. Pupils' preference for school subjects, III, 226.
Chatterji, B. K. *See* Mitra, A. K., and B. K. Chatterji.
Chatterji, (Mr.) G. C., IV, 55.
Chattopadhay, K. P. Determination of the nasion in the living, III, 149.
Chattopadhyay, (Prof.) K. P., IV, 22, 56.
Chattopadhyay, K. P. A case of temporary loss of memory, III, 228.
Chattopadhyay, K. P. Bengal Coiled Baskets, IV, 7.
Chaudhuri, B. K. Notes on the different types of apparatus used for smoking 'Pancharang', III, 153.
Chaudhuri, Nanimadhab. The Sun as a folk god, III, 153.
Chemical elements and radicles—Analogy among, II, 45.
Chemiotherapy of Schizophrenia, III, 228.
Chemistry—Analytical, III, 98.
„ —Industrial, III, 85.

Chemistry—Inorganic, III, 37.
,, —Organic, III, 60.
,, —Physical, III, 43.
Chemistry—Section of, II, 45; III, 37.
Chemotherapy of bacterial infections, III, 97.
Cherian, M. C., and K. P. Anantanarayanan. A caterpillar pest of grasses in S. India (*Cirphis albistigma*), III, 195.
Cherian, M. C., and Mohamad Basheer. A new caterpillar pest of moringa in S. India (*Noorda moringæ* T), III, 195.
Cherian, M. C., and P. Israel. A bethylid natural enemy of the sugarcane white moth borer, III, 195.
Cherian, M. C., M. S. Kylasam, and P. S. Krishnamurthi. Further studies on the cholam earhead bug (*Calocoris angustatus*) in S. India, III, 196.
Cherian, M. C. *See* Rao, Y. Ramachandra, and M. C. Cherian.
Chettiyar, C. M. Ramachandra. The growth of a modern city, III, 110.
Chetty, V. V. *See* Nair, V. Govindan, and V. V. Chetty.
Cheyyar basin—The, III, 113.
Chima, I. S. *See* Luthra, J. C., and I. S. Chima.
Chiplonkar, M. W. Inter-diurnal variability of pressure and temperature at different levels over Agra in N. India during the period November to April, III, 19.
Chiplonkar, M. W. On the brightness of the Zenith sky during twilight on clear evenings and the variation of temperature with height in the upper atmosphere, III, 15.
Chiplonkar, M. W. Spectroscopic determination of the amount of ozone in the atmosphere over Bombay, III, 14.
Chiplonkar, V. T. 'Chemical clean up' in a positive ray tube, III, 25.
Chiplonkar, V. T. Localisation of discharge in a positive ray tube, III, 25.
Chiplonkar, V. T. Ring deposits due to bombardment by positive rays, III, 26.
Chiplonkar, V. T. *See* Joshi, S. S., V. T. Chiplonkar, and G. S. Deshmukh.
Chiplonker, G. W. Rhynchonellids from the Cretaceous Series of South India, III, 108.
Chittagong Hill Tracts, Bengal—Naturvolkers of, III, 109.
Chopra, N. N. Morphology and physiology of indigenous yeasts, III, 97.
Chopra, N. N. Sugar-acid-pectin relationship in the stabilization of fruit juices, III, 96.
Chopra, R. N. *See* Mukerji, B., and R. N. Chopra.
Choudhury, A. *See* Goswami, M., and A. Choudhury.
Chowdhury, D. K. *See* Ghosh, B. N., and D. K. Chowdhury.
Chowdhury, H. D., S. N. Mukerji, A. N. Kapoor, and J. S. Aggarwal. The use of vegetable oils as fuels for internal combustion engines, III, 32.
Chowdhury, K. Ahmad, IV, 12.
Chowdhury, K. Ahmad, and S. Ghosh. On the anatomy of a fossil dicotyledonous wood from Nailalung, Assam, III, 127.
Chowdhury, K. Ahmad. Relation between cambial activity and foliar development in some forest trees, III, 125.
Chromite deposit of Jojohatu, Singhbhum—Geology of the, III, 104.
Chromium chromates, III, 37.
Coagulation and gelation by viscosity and opacity measurements—Studies in, III, 51.
Cochin—Fisheries of, III, 110.
Cod liver oil in the Indian market—quality of, IV, 10.
Colour memory—an experimental study, III, 220.
Colour on the estimation of area—The influence of, III, 220.
Committee—Executive, I, 6.
Committee—Members of the Local Reception, I, 12.
Committees—Sectional, I, 7.

Complex ions in aqueous silver nitrate in the presence of sucrose—Formation of, III, 47.

Composting Method, IV, 42.

Composts, IV, 41.

Condensation of C-acetyl-methone with aromatic aldehydes, III, 60.

Condensation of methyl β-resorcylate with ethyl acetone dicarboxylate and ethyl α-chloroacetoacetate, III, 61.

Condensation of methyl succinic anhydride with phenolic ethers, III, 60.

Condensation of *o*-, *m*-, and *p*-nitrobenzaldehydes with malonic acid in the presence of organic bases, III, 61.

Condensation of protocatechuicaldehyde with malonic acid in the presence of organic bases. Synthesis of caffeic acid, III, 61.

Condensation of shellac and shellac acids with alcohols, aldehydes, acids and acid anhydrides, III, 88.

Conductivity of the upper atmospheric layers responsible for the solar diurnal variation—The, II, 28.

Conservation of Fuel Minerals, II, 67.

Conservation of India's Mineral Wealth, II, 65.

Conservation of other Minerals, II, 83.

Continuous spectrum of helium, III, 21.

Conversion hysteria—A contribution to the study of, III, 229.

Cooper, (Dr.) H. R., IV, 43.

Coorg—Geographical personality of, III, 114.

Coramine as an analeptic—Some observations on the action of, III, 216.

Cordierites from Mysore, III, 105.

'Coronary occlusion'—Further observations on, III, 162.

Correspondents—Sectional, I, 4.

Coumarino-coumarin, coumarino-chromone, and chromono-chromone derivatives—Synthesis of, III, 66.

Coumarins from *o*-hydroxy-aryl alkyl ketones—Synthesis of, III, 65.

Council, I, 6.

Cowalagi, S. S. *See* Rothenheim, C. A., and S. S. Cowalagi.

Crop pests and diseases, III, 190.

Crop response to winter cultivation in Malwa, III, 184.

Cultural Groups, II, 189.

Cultural groups—General economic life of the, II, 194.

Cultural institution—Indigenous, II, 199.

Cultures and acculturation—Tribal, II, 179.

Customs of the Sansi tribe—Psychological aspects of some, III, 231.

D

Dakshinamurti, C., and B. Dasannacharya. Mercury arc lamps of exceedingly long life and made of soft glass, III, 27.

Dalal, H. S. *See* Kalapesi, A. S., and H. S. Dalal.

Dalal, N. M., and T. N. Mehta. Cracking of vegetable oils. Part I. Groundnut oil, III, 92.

Das, B. K. On the bionomics, structure and physiology of respiration in an air-breathing brackish water eel, *Pisoodonophis boro* (Ham. Buch.), III, 133.

Das, G. K. *See* Dasannacharya, B., and G. K. Das.

Das Gupta, D. *See* Guha, P. C., and D. Das Gupta.

Das Gupta, P. *See* Basu, U. P., and P. Das Gupta.

Das Gupta, P. N. On an interpolation formula for triple integration, III, 4.

Das Gupta, S. N., and (Miss) A. T. Zachariah. Studies in the diseases of *Mangifera indica* Linn. III. On the 'die-back' disease of the mango tree, III, 117.

Das Gupta, S. N., and S. Sinha. Studies in the diseases of the *Mangifera indica* Linn. II. Investigation into the pathological histology of the fruits affected with black-tip disease, III, 117.

Das Gupta, S. N., and T. S. Sadasivan. *Neotiella catharinœa* McLennan and Halsey on *Catharinœa mülleri*, III, 118.

Das, N. N., and N. N. De. Electrical stimulation of cerebral cortex followed by spreading and rhythmic grouping of brain potentials, III, 203.
Das, N. N. Tissue culture—its application in medical and biological researches, IV, 9.
Das, T. C. Notes on a fish-gorge from Bengal, III, 155.
Dasannacharya, B., and A. C. Seth. Optical silvering on glass by the chemical method and the critical rôle of the extent of surface, III, 35.
Dasannacharya, B., and A. C. Seth. The counting in Geiger point counter, III, 27.
Dasannacharya, B., and B. S. Gautam. The law of ellipticity for the minor axis in a Foucault's pendulum, III, 34.
Dasannacharya, B., and G. K. Das. A new type of Doppler effect in positive rays of hydrogen, III, 26.
Dasannacharya, B., and G. K. Das. The Doppler effect with positive rays of mercury, III, 26.
Dasannacharya, B. *See* Dakshinamurti, C., and B. Dasannacharya.
Dasgupta, D. C. Naturvolkers of Chittagong Hill Tracts, Bengal, III, 109.
Dassanayake, W. L. P. The incidence of Filariasis in relation to malaria in Ceylon, III, 160.
Datta, A. *See* Mitra, S. C., and A. Datta.
Datta, S., and G. Karmakar. Note on a change in the transition probability of sodium atoms in absorption, III, 20.
Datta, S., and G. Karmakar. On the identification of the Sun-spot line at λ 6708A, III, 20.
De, Lakshmikanta. *See* Mitter, P. C., and Lakshmikanta De.
De, N. N. *See* Das, N. N., and N. N. De.
De, S. C. *See* Sen, H. K., M. Venugopalan, and S. C. De.
Dearborn Formboard tests—Application of, III, 226.
Deficiency diseases of animals in India, III, 177.
Dehydration of fuller's earth, III, 53.
Delegates, I, 25.
Deo, L. R. S. Bacteriophage and candle filtration, III, 163.
Desai, C. M., and B. K. Vaidya. Action of light on some organic colouring matters, III, 54.
Desai, M. B., and K. Venkataraman. The use of emulsified organic solvents in textile processing, III, 90.
Desai, R. D., and G. S. Sahariya. The alkyration of 2-methyl-, 3-methyl and 4-methyl-cyclohexylidene cyanoacetates, III, 74.
Desai, R. D., and (Miss) V. M. Vakil. Studies in the Friedel-crafts reaction. Part V. The action of acid chlorides and anhydrides on orcinol and resorcinol derivatives, III, 62.
Desai, R. D., Ashraff Ali, and H. P. Shroff. Studies in the naphthalene series. Part III. The synthesis of 2-butyl and 4-butyl-α-naphthols and some mixed diacyl-α-naphthols, III, 62.
Desai, R. D., R. F. Hunter, and G. S. Sahariya. Studies in cyclohexane series. Part IV. The synthesis of 4-methylcyclohexane 1 : 1-dicarboxylic acid and 3-methylcyclohexane-1 : 1-dicarboxylic acids, III, 63.
——— Studies in the cyclohexane series. Part V. Synthesis of 2-methyl-, 3-methyl-, and 4-methylcyclohexane-1-carboxy-1-α-benzylacetic acids, III, 63.
Desai, R. D. *See* Ahmad, Nazir, R. D. Desai, and G. S. Sahariya.
Desai, V. D. *See* Tawde, N. R., and V. D. Desai; also Tawde, N. R., Y. G. Naik, and V. D. Desai.
Descriptive account of Bastar State, II, 182.
Deshmukh, G. S. *See* Joshi, S. S., and G. S. Deshmukh; also Joshi, S. S., V. T. Chiplonkar, and G. S. Deshmukh.
Detection of anthrax in food stuffs in an outbreak among mules, III, 172.
Devanesan, D. W., and S. Varadarajan. On *Cœloplana* spp. discovered by Prof. Tallersall at Krusadai Island, Marine Biological Station, Gulf of Manaar, III, 129.

Dextro-rotatory hydrocupreidine derivatives. Part III. Action on *Paramoecium caudatum*—Studies on some, III, 214.

Dhanda, M. R. *See* Hassan, S. R., and M. R. Dhanda.

Dhannalal. *See* Kalamkar, R. J., and Dhannalal.

Dhar, B. K. Root studies of sugarcane in different types of soil under field conditions, III, 188.

Dhar, S. C. On certain self-reciprocal functions, III, 2.

Dharwarkar, H. V., and R. L. Alimchandani. Studies in hydroxy and methoxy benzoic acids, III, 66.

Dhillon, G. S. A study of *Monascus* occurring in orange-squash, III, 118.

Dhillon, G. S. *Acrothecium lunatum* on *Pennisetum typhoideum* ears, III, 118.

Dhillon, G. S. Effect of certain poisonous chemicals upon the spores of *Acrothecium lunatum* and *Cephalothecium roseum*, III, 118.

Dhillon, G. S. Two species of *Spicaria* from interesting habitats, III, 118.

Diamagnetic and drift-current theories of solar diurnal variation, II, 30.

Diamagnetic susceptibility of chlorohydrate, III, 44.

Dielectric constant and electrical conductivity of gases and vapours ionized by X-rays at ultra-high radio frequency—The, III, 24.

Dielectric constant and electrical conductivity of ionized air in a discharge tube—The ultra-high frequency, III, 24.

Dielectric constants of certain liquids with special reference to dispersion at audio frequencies, III, 29.

Diet in requirement of copper for infants, III, 166.

Dietetics and nutrition, II, 327.

Diffusion analysis of sodium silicate solutions, III, 52.

Diplodia agaves—Leaf spots of Agave americana Linn. caused by, IV, 5.

Discussion, IV, 13.

Disease and Pest Resistance in crops, IV, 27.

Dissociation constants of catechol, resorcinol, hydroquinone, pyrogallol and phloroglucinol, III, 48.

Dissociation constants of hydroxy-benzoic acids and gallic acid, III, 48.

Dissociation constants of tannic acids, III, 48.

Diurnal variation field—The Lunar, II, 24.

Diurnal variation in the temperature and humidity distribution up to 3 km. over Karachi, III, 17.

Diurnal variations of the earth's magnetic field and their analysis—The Solar, II, 22.

Divisions—Ethnological and linguistic, II, 183.

Doja, M. Q. Photosensitizing dyes. The influence of anions on the properties of dyes derived from α-picoline, III, 83.

Doppler effect in positive rays of hydrogen—A new type of, III, 26.

Doppler effect with positive rays of mercury—The, III, 26.

Doss, K. S. Gururaja. The nature of the potential barrier at surfaces of solutions of capillary-active electrolytes, III, 49.

Drainage Problems in India, IV, 38.

Drainage Problems in India—Erosion and, IV, 36.

Drift-current theories of solar diurnal variation—Diamagnetic and, II, 30.

Duegan, B. S., K. S. Narang, and J. N. Ray. Acridine derivatives. Part II, III, 64.

Duegan, B. S., K. S. Narang, and J. N. Ray. Experiments on the synthesis of podophyllotoxin and podophyllin, III, 75.

Dutt, J. *See* Chakravarti, D., and J. Dutt.

Dutt, N. *See* Chakravarti, D., and N. Dutt.

Dutt, N. K. *See* Rây, P. R., N. K. Dutt, and T. C. Sarkar.

Dutt, (Mr.) N. L., IV, 31.

Dutt, N. L. Certain suggested floral characters for distinguishing commercial sugarcane varieties, III, 187.

Dutta, H. K. Euphorbiaceæ of the town of Dacca and its neighbourhood, III, 128.

Dutta Roy, R. K. Studies on some characteristics of Indian coking coals, III, 86.

Dynamic Geography of India, II, 118.
Dynamic structure of personality—Patterns of, II, 357.
Dynamic structure of the human personality, II, 341.
Dynamic theory of personality in a biological perspective, II, 348.

E

Earth's Magnetism and the Upper Atmosphere—The, II, 19.
Earth's permanent magnetic field and its harmonic analysis—The, II, 19.
Ecology—Physiology and, III, 125.
Economic life of the cultural groups—General, II, 194.
Education and Tests, III, 224.
Education in India—Psychology in the Service of, IV, 52.
Elasticity—Some boundary value problems of the theory of, III, 6.
Electric discharge through gases and related phenomena, III, 24.
Electrical rhythm from the intact human brain, III, 233.
Electrochemistry of resin solutions, III, 45.
Electro-deposition of chromium—Theory of, III, 47.
Electro-deposition of nickel on iron—Effect of inorganic colloids on the, III, 48.
Electrolysis of aqueous magnesium chloride solutions, III, 39.
Electrons—The equilibrium between neutrons, protons, and, III, 11.
Embryo-sac and pollen development in *Iphigenia indica* (Liliaceæ), III, 122.
Emotional growth in the education of a child, IV, 11.
Emotions in mystic life—The culture of, III, 230.
Endemic fluorosis in the Province of Madras, III, 158.
Endogenous protein metabolism of man and the distribution of sulphur in human urine on non-protein diet and on diets containing different amount of proteins of rice and whole wheat (Atta), III, 210.
Entertainments—Functions and, I, 17.
Entomology, III, 138, 173.
Entomology in India—Some observations on existing conditions and suggestions regarding the future of economic, II, 306.
Entropy of Fermi-Dirac gas, III, 13.
Environmental and genetical factors on fibre maturity of cotton—The effect of, III, 189.
Enzymes in snake venom, III, 96.
Errata and Addenda, IV, 12.
Erosion and Drainage Problems in India, IV, 35.
Esh, G. C., and S. S. Guha Sircar. A comparison of the properties of 'humic acid' obtained from different sources, III, 52.
Essential oils—Some Northern India, III, 93.
Esterification equilibria in vapour phase, III, 55.
Ethnography, III, 150.
Ethnological and linguistic divisions, II, 183.
Ethnology, III, 149.
Examination and instruction—The medium of, III, 225.
Excursions—Visits and, I, 18.
Experimental Field Trials, IV, 45.

F

Fabri, (Dr.) C. L., IV, 21.
Factorial school—This 'Factory' of, III, 223.
Factors Determining Changes in Religious Phenomena, IV, 55.
Farooq, M. Omar. The reactions of ketones with unsaturated hydrocarbons, III, 85.
Fatal poisoning by paranitraniline, III, 166.
Fazlor Rahman, Shah Md. *See* Khastgir, S. R., and Shah Md. Fazlor Rahman.
Fear and anger responses of adults, III, 221.
Feeble-minded children—Behaviouristic peculiarity of, III, 233.
Fibre-strength—A self-recording apparatus for determination of, III, 30.

Figuring of a 24″ reflector made in India—The, IV, 3.
Filariasis in relation to malaria in Ceylon—The incidence of, III, 160.
Flora of Mussoorie—The, III, 126.
Floral characters for distinguishing commercial sugarcane varieties—Certain suggested, III, 187.
Fog at Karachi Air Port, Drigh Road, III, 18.
Foot, (Mr.) A. E., IV, 53.
Forest mycology with special reference to forest pathology—Indian, II, 141.
Forest pathology—Forest mycology with special reference to, II, 141.
Forster, R. B., R. C. Gandhi, and K. Venkataraman. The estimation of salicylanilide in textiles, III, 91.
Forster, R. B. *See* Banerjea, H. N., L. A. Bhatt, and R. B. Forster; also Bhat, R. V., R. B. Forster, and K. Venkataraman.
Foucault's pendulum—The law of ellipticity for the minor axis in a, III, 34.
Frigidity in women—Therapeutical indications of, III, 228.
Fringe of the outer atmosphere—The, III, 13.
Fuel Minerals—Conservation of, II, 67.
Fuller's earth—Dehydration of, III, 53.
Functions and entertainments, I, 17.
Functions which are Hankel transforms of each other—A pair of, III, 2.
Fungi, III, 115.

G

Gadre, K. M. *See* Ramdas, L. A.
Gaind, K. N., and J. N. Ray. New local anæsthetics. Part IV, III, 101.
Gajendragad, N. G. *See* Jatkar, S. K. K., and N. G. Gajendragad.
Gametophyte in *Oligomeris glaucescens* Cambess—Development of the female, III, 124.
Ganapathi, K. Chemotherapy of bacterial infections, III, 97.
Ganapathi, K. Configuration of the 2 : 3-dihydroxy transdecalins, III, 69.
Ganapathi, K. The stereochemistry of pinane and its derivatives, III, 69.
Ganapathy, C. V., and B. N. Sastri. Natural activator of papainases, III, 206.
Ganapathy, C. V., and B. N. Sastri. The active group of papain, III, 206.
Ganapati, P. N. The morphology and life-history of a Coccidian *Myriospora polydorae* n.sp., in the body-cavity of *Polydora ciliata*, III, 129.
Gandhi, R. C. *See* Forster, R. B., R. C. Gandhi, and K. Venkataraman.
Ganguli, H. D. *See* Bagchi, K. N., H. C. Chakravarti, and H. D. Ganguli; also Bagchi, K. N., H. D. Ganguli, and P. N. Mukerjee.
Ganguli, M. Visual perception of geometrical figure in indirect vision, III, 219.
Ganguli, N. *See* Krishnan, K. S., and N. Ganguli.
Ganguli, P. M. *See* Nandi, H. K., and P. M. Ganguli.
Ganguly, D. *See* Bose, G., and D. Ganguly.
Ganguly, H. D. *See* Bagchi, K. N., H. D. Ganguly, and J. N. Sirdar.
Ganguly, P. B. *See* Ray, R. C., and P. B. Ganguly.
Ganjoo, P. N. *See* Nath, Raj, and P. N. Ganjoo.
Gastro-intestinal tract in cholera—Studies in the pathology of the, III, 161.
Gautam, B. S. *See* Dasannacharya, B., and B. S. Gautam.
Geddes, (Dr.) A. F., IV, 17.
Geddes, Arthur F. Some dynamic problems of Indian Geography, III, 110.
Geiger point counter—The counting in, III, 27.
Gels of sodium oleate—Studies in, III, 51.
General Economic life of the cultural groups, II, 194.
General Education—The Place of Physiology in, IV, 46.
Geographical Personality of India—The, II, 99.

Geography and Geodesy—Section of, II, 99; III, 109.
Geography of India—Dynamic, II, 118.
Geography of India, Static, II, 100.
Geology—Economic, III, 103.
Geology—Section of, II, 65; III, 103.
Geometrical figure in indirect vision—Visual perception of, III, 219.
Ghaffar, A. Histological chemistry of voluntary muscle, III, 210.
Gharpure, D. V. *See* Karve, D. D., and D. V. Gharpure.
Ghatak, N., and Lal C. Verman. Setting properties of red lead paints, III, 85.
Ghatak, N. *See* Karimullah, N. Ghatak, J. S. Aggarwal, and Lal C. Verman; also Verman, Lal C., N. Ghatak, and H. Trivedi; also Verman, Lal C., H. Trivedi, and N. Ghatak.
Ghatak, P. N. Investigation of orange rot in storage, III, 116.
Gheba, (Mr.) U. S., IV, 54.
Gheba, U. S. Emotional growth in the education of a child, IV, 11.
Ghosh, B. C. Psycho-ethics: ancient and modern, III, 222.
Ghosh, B. N., and D. K. Chowdhury. Enzymes in snake venom, III, 96.
Ghosh, B. N., and P. C. Adhya. Some observations on the action of coramine as an analeptic, III, 216.
Ghosh, (Prof.) J. C. Presidential Address, II, 1.
Ghosh, R. *See* Mukerji, B., and R. Ghosh.
Ghosh, S. S., S. K. Rcy, and B. C. Roy. Low temperature carbonization of Indian coals, III, 86.
Ghosh, S. M. *See* Chatterjee, H. N., and S. M. Ghosh.
Ghosh, S. *See* Chowdhury, K. Ahmad, and S. Ghosh.
Giri, K. V. Interaction of Vitamin C and tissue phosphatases, III, 166.
Giri, K. V., K. L. Shourie, and K. Rajagopal. Serum phosphatase activity in rats fed with different diets, III, 165.
Giri, K. V. The availability of cereal phosphorus and calcium for rats, III, 165.
Glossiphonia reticulata, from the mantle of *Lamellidens*, the common freshwater mussel of Lucknow, IV, 7.
Glover, (Dr.) P. M., IV, 32, 40.
Glover, P. M. Practicability of biological control in the lac industry, III, 142.
Glover, P. M. *See* Gupta, S. N., and P. M. Glover.
Gneissic topography of Ranchi Plateau, Chota Nagpur, III, 109.
Gogte, G. R. C-Acetylation of β-aryl-glutaconic anhydrides: Formation of αγ-diaceto-β-aryl-glutaconic anhydrides, III, 70.
Gogte, G. R. C-Benzoylation of β-aryl-glutaconic anhydride, III, 69.
Gokhale, S. K. Nonprotein nitrogenous constituents of blood, III, 208.
Gopalakrishnan, V. R. *See* Rajagopalan, V. R., and V. R. Gopalakrishnan.
Gopalarao, G. *See* Rao, W. V. B. Sundara, P. V. Krishnamurty, and G. Gopalarao.
Gorrie, (Dr.) R. Maclagan, IV, 37.
Gorrie, R. Maclagan. The work of the Forest Research Institute, Dehra Dun, III, 128.
Goswami, H. *See* Basu, U. P., and H. Goswami.
Goswami, M., and A. Choudhury. Sulphocyanide value of oils, III, 94.
Goswami, M. N., and Sibsankar Chatterjee. Application of H.C. value method in determination of unsaturation, III, 62.
Goswami, M. N. Catalytic polymerization of oils, III, 93.
Gram germ oil—Constituents of, III, 93.
Gravitational influence of radiation on radiation—On the, III, 12.
Grid sampling—A note on, III, 7.
Group-characters for the determination of normal modes—The application of, III, 1.
Group tests of intelligence for Bengali scholars (Class V–Class X), III, 225.
Groups, Cultural, II, 189.

Guha, A. K. *See* Sircar, A. C., and A. K. Guha.
Guha, B. S. Indian Basketry—their texture and design, III, 150.
Guha, P. C., and C. Krishnamurthy. Synthesis of bicyclo-(2 : 2 : 2)-octane-(1 : 4)-dione, III, 81.
Guha, P. C., and D. Das Gupta. On the synthesis of 2 : 2 : 3-trimethyl-cyclohexan-4-one-1-carboxylic acid, III, 82.
Guha, P. C., and D. K. Sankaran. Synthesis of carane, III, 79.
Guha, P. C., and G. D. Hazra. Action of aliphatic diazo-compounds on cyclic conjugated double bonded systems, III, 76.
Guha, P. C., and K. S. Subramanian. On synthesis of homocamphoronic and canphononic acids, III, 77.
Guha, P. C., and M. S. Muthanna. A new method of synthesis of umbellularic acid, III, 79.
Guha, P. C., and M. S. Muthanna. Attempts towards synthesis of thujadicarboxylic acid and thujaketonic acid, III, 80.
Guha, P. C., and M. S. Muthanna. On synthesis of sabina ketone, III, 81.
Guha, P. C., and M. S. Muthanna. Researches on total synthesis of thujone, III, 80.
Guha, P. C., and P. L. Narasimha Rao. Synthetical experiments in the pinane group. Experiments towards the synthesis of pinonic acid, III, 78.
Guha, P. C., and P. L. Narasimha Rao. Synthetical experiments in the pinane group. The configuration of α-bromopinic acid and α-hydroxypinic acid, III, 78.
Guha, P. C., and V. Rama Iyer. Synthesis of lauralonic acid, III, 77.
Guha, P. C. Bridging of succinosuccinic ester: On synthesis of compounds of tricyclene type, III, 76.
Guha, S. K. Indigoid vat dyes of the isatin series. Part III, III, 83.
Guha, S. K. Studies in indigoid dyes. Part IV, III, 83.
Guha Sircar, S. S. *See* Esh, G. C., and S. S. Guha Sircar.
Gulati, A. N., and N. Ahmad. The effect of environmental and genetical factors on fibre maturity of cotton, III, 189.
Gulati, A. N. *See* Ahmad, N., and A. N. Gulati.
Gupta, R. L. *See* Ahmad, Taskhir, and R. L. Gupta.
Gupta, S. N., and P. M. Glover. The economic importance of *Microbracon greeni* Ash an ecto-parasite of *Eublemma amabilis*, the major predator of *Laccifer lacca*, lac, III, 142.

H

Hæmolymph organs in cholera—Studies in the pathology of, III, 160.
Hæmopis sp. from Kashmir (India)—An Arhynchobdellid leech, IV, 6.
Hai, M. A. *See* Qureshi, M., and M. A. Hai.
Haldar, M. K. *See* Basu, K. P., M. N. Basak, and M. K. Haldar.
Halogenation. Part XXIII. Halogenation of 2 : 6 dimethylnaphthalene, III, 73.
———— Part XXIV. Halogenation of acenaphthene, III, 73.
Hariharan, S. *See* Parameswaran, H., and S. Hariharan.
Harmonic analysis—The Earth's permanent magnetic field and its, II, 19.
Hashmi, M. S. *See* Bhatnagar, S. S., P. L. Kapur, and M. S. Hashmi.
Hassan, S. R., and M. R. Dhanda. Observations on malaria in buffaloes, III, 170.
Hazra, G. D. *See* Guha, P. C., and G. D. Hazra.
Heinrich, J. C. Social psychology and rural reconstruction, III, 230.
Helium—Continuous spectrum of, III, 21.
Helium II—Liquid—Thermal properties of films of, III, 33.
Helium II—Liquid—Transfer of, III, 34.
Helminthology, III, 175.
Heterogeneous systems—Hydrolysis of esters in—IV, 4.

Hindu conception of the unity of life—Religion, Morals and Science, II, 234.
Hindu Medical Sciences—Ancient, II, 231.
Hippocratic medicine of Alexandria—Post-, II, 240.
Histological chemistry of voluntary muscle, III, 210.
History of bacteriology—The, II, 255.
History of pathology—A brief account of the, II ,225.
Hobson, W. A. A psychoanalytical study in marriage, III, 227.
Hot-wire anemometer in studies of microclimates—The use of the, III, 201.
Human personality—Dynamic structure of the, II, 341.
Hunter, R. F. *See* Desai, R. D., R. F. Hunter, and G. S. Sahariya.
Husain, (Mr.) Aftab, IV, 49.
Husain, Asrar. *See* Asundi, R. K., and Asrar Husain.
Husain, M. Afzal, and G. S. Sohi. Light reations of *Trogoderma Khapra* adults, III, 196.
Husain, S. Theory of electro-deposition of chromium, III, 47.
Hussain, A. *See* Bhatnagar, S. S., P. L. Kapur, and A. Hussain.
Hydrolysis of esters—Studies in the, Part I, III, 47.
Hyper-Grœco Latin Square—On the completely orthogonalized, III, 8.

I

India—Dynamic Geography of, II, 118.
India—Static Geography of, II, 100.
India—The Geographical Personality of, II, 99.
Indian diet—Biological value of the proteins of a few typical, III, 95.
Indian forest mycology with special reference to forest pathology, II, 141.
Indian Geography—Some dynamic problems of, III, 110.
Indigenous cultural institution, II, 199.
Indigoid dyes—Studies in. Part IV, III, 83.
Indigoid vat dyes of the isatin series. Part III, III, 83.
Infantile biliary cirrhosis being found in castor oil—A preliminary report on the possible etiological factor in the causation of, III, 157.
Infantile cirrhosis (A case report), III, 157.
Infantile cirrhosis—Epidemiology of, III, 158.
Infectivity of eggs in Doyle's (Ranikhet) disease, III, 178.
Infinite series involving the product of Bessel functions and Weber's parabolic cylinder functions—Some, III, 2.
Infra-red content of the solar radiations at Bombay—Variation of the relative, III, 23.
Insect injury and incidence—Nature and range of, II, 284.
Insect pest control in India, II, 293.
Insects and human interests, II, 277.
Insects—Extent of damage and loss caused by noxious, II, 279.
Insects: Status among animals and their striking features, II, 274.
Instincts in psycho-analysis, III, 229.
Institution of advanced culture, II, 211.
Institution—Indigenous cultural, II, 199.
Institution—Origin of the, II, 208.
Integral equations—Non-linear—Further contributions to the theory of, III, 1.
Integral functions of finite order—On, III, 3.
Intelligence—Some aspects of measurement of, III, 226.
Intensity of the ionization of the earth's atmosphere—On the, III, 14.
Inter-diurnal variability of pressure and temperature at different levels over Agra in N. India during the period November to April, III, 19.
Internal combustion engines—The use of vegetable oils as fuels for, III, 32.
Internal constitution of white dwarf stars and the planets, III, 13.
Interpolation formula for triple integration—On an, III, 4.

Intestinal paramphistomiasis of sheep in Sind—A preliminary report on, III, 176.
Iodine I(VI) and I(VII)—The higher spark-spectra of, III, 21.
Iodine I(V)—The higher spark-spectra of, III, 21.
Ionization in the earth's atmosphere—On the intensity of the, III, 14.
Ipomœa hispida, Roem and Sch., a useful fodder weed, III, 182.
Isomerization of oleic acid by nickel catalyst, III, 70.
Israel, P. *See* Cherian, M. C., and P. Israel.
Iyengar, (Dr.) A. V. V., IV, 31.
Iyengar, N. K., and B. Mukerji. The influence of ascorbic acid on the oxidases acting on adrenalin, III, 207.
Iyengar, N. K. *See* Mukerji, B.
Iyenger, N. K., and B. Mukerji. Quality of cod liver oil in the Indian market, IV, 10.
Iyer, A. Neelakanta. *See* Venkitasubban, C. S., and A. Neelakanta Iyer.
Iyer, B. H. Condensation of C-acetyl-methone with aromatic aldehydes, III, 60.
Iyer, (Mr.) K. R. Narayana, IV, 44.
Iyer, L. A. Krishna. The disposal of the dead among the primitive tribes of Travancore, III, 152.
Iyer, P. V. Seetharama, and T. N. S. Raghavachari. The technique of M.R. and V.P. tests used in bacteriological water analysis, III, 162.
Iyer, P. V. Seetharama. *See* Raghavachari, T. N. S., and P. V. Seetharama Iyer.
Iyer, S. Ganapathy. On the successful experimental transmission of variola in goats in a generalise form, III, 179.
Iyer, S. Ganapathy. Paralysis in a pigeon due to Doyle's (Ranikhet) disease, III, 179.
Iyer, S. Ganapathy. *See* Kaura, R. L., and S. Ganapathy Iyer.
Iyer, S. Ganapathy. Some observations on the viability of Doyle's (Ranikhet) disease virus of fowls under different conditions, III, 179.
Iyer, S. Ganapathy. Visceral gout of fowls in India, III, 170.
Iyer, V. Rama. *See* Guha, P. C., and V. Rama Iyer.

J

Jalota, S. S. The medium of examination and instruction, III, 225.
Jatkar, S. K. K., and N. G. Gajendragad. Equilibrium between methyl alcohol, acetic acid, methyl acetate and water, III, 55.
Jatkar, S. K. K., and (Miss) Nagamani Shama Rao. Absorption from binary mixtures, III, 56.
Jatkar, S. K. K., and (Miss) Nagamani Shama Rao. Studies in binary mixtures, III, 55.
Jatkar, S. K. K., and R. K. Valvekar. Activity of different catalysts for vapour phase esterification, III, 55.
Jatkar, S. K. K., and S. R. Sunthankar. Dissociation constants of tannic acids, III, 48.
Jatkar, S. K. K. *See* Abichandani, C. T., and S. K. K. Jatkar.
Jatkar, S. K. K. *See* Athavale, V. T., and S. K. K. Jatkar.
Jatkar, S. K. K. *See* Joglekar, R. V., V. T. Athavale and S. K. K. Jatkar.
Jatkar, S. K. K. *See* Krishnan, R., and S. K. K. Jatkar.
Jatkar, S. K. K. *See* Kulkarni, B. S., and S. K. K. Jatkar.
Jatkar, S. K. K. *See* Subramanya, T., and S. K. K. Jatkar.
Jayaraman, N. Miscibility amongst the various feldspar members as revealed by a study of the feldspars from the micapegmatites of Nellore, III, 104.
Jayaraman, N. On the origin of the charnockites, III, 106.
Jayaraman, N. Tremolite marbles from Singareni, Warangal District (Hyderabad), III, 107.

Joglekar, G. D., and Lal C. Verman. Automatic cell-testing device, III, 31.
Joglekar, G. D., K. Subba Ramaiah, D. S. Naidu, and Lal C. Verman. Characteristics of dry cells made from various Indian pyrolusite ores, III, 86.
Joglekar, R. V., V. T. Athavale, and S. K. K. Jatkar. Hydrogenation of oils by the continuous process, III, 91.
Joglekar, S. Y. *See* Ramdas, L. A., and S. Y. Joglekar.
John, V. On the food and the spawning season of *Sardinella brachysoma* (Bleek), III, 134.
Joshi, A. C. Determination of sex in plantain flowers, III, 120.
——— Embryo-sac and pollen development in *Iphigenia indica* (Liliaceæ), III, 122.
——— Morphology of *Tinospora cordifolia* Miers, with a discussion on the origin of the single integument, nature of synergidæ and relationships of the menispermaceæ, III, 123.
——— Origin of the lateral styles, III, 121.
——— Origin of the seed habit, III, 122.
——— Relationships of the *Lythraceæ* and allied families, III, 123.
——— Some abnormal flowers of *Argemone mexicana* and their bearing on the morphology of the gynæceum of Papaveraceæ, III, 122.
——— The origin of the angiosperms: A review of the present position, III, 121.
Joshi, P. C. Development of the female gametophyte in *Oligomeris glancescens* Cambess, III, 124.
Joshi, S. S., and A. Purushotham. Studies in active nitrogen. Part II, III, 41.
Joshi, S. S., and A. Purushotham. Studies in active nitrogen. Part III, III, 42.
Joshi, S. S., and D. N. Solanki. The temperature coefficients of electrical conductivity and viscosity of aqueous mercuric chloride at different temperatures, III, 45.
Joshi, S. S., and Gopal Tripathi. Electrolytic formation of calcium chlorate from aqueous calcium chloride by electrolysis, III, 40.
Joshi, S. S., and G. K. Nayar. Luminescence of phosphorus under electric discharge, III, 59.
Joshi, S. S., and G. S. Deshmukh. Behaviour under high tension electric discharge of films of nitrous oxide at liquid air temperature, III, 56.
Joshi, S. S., and K. S. Visvanathan. Behaviour of nitrogen peroxide under electric discharge. Anomalous pressure reversal effect, III, 39.
Joshi, S. S., and K. Srinivasan. Electrolytic formation of sodium chlorate from brine mixtures, III, 40.
Joshi, S. S., and L. S. Chandrakant. Synthesis of potassium permanganate from Indian raw materials, III, 40.
Joshi, S. S., and Sankaranand Mukherji. Formation of complex ions in aqueous silver nitrate in the presence of sucrose, III, 47.
Joshi, S. S., and T. D. Bhaskar. Decomposition of phosphine under electric discharge, III, 39.
Joshi, S. S., and V. C. Subbaiah. Influence of electric fields on the viscosity of colloids, III, 50.
Joshi, S. S., and Victor Caldwell. Electrolysis of aqueous magnesium chloride solutions, III, 39.
Joshi, S. S., and V. Narasimhan. The hydrogenchlorine reaction due to electronic activation, III, 57.
Joshi, S. S., V. T. Chiplonkar, and G. S. Deshmukh. Periodic deposits under canal ray discharge, III, 59.
Juice in sugarcane—Variations in the concentration of, III, 183.

K

Kalamkar, R. J., and Dhannalal. Variability of plant density and the estimation of yield of cotton by sampling, III, 198.

Kalapesi, A. S., and H. S. Dalal. The occurrence of acid rocks in the Deccan Trap of the north of Salsette Island, Bombay, III, 105.

Kalia, P. N. *See* Ram, Mela, P. N. Kalia, and B. M. Anand.

Kamat, R. K., and T. S. Wheeler. Studies in the chemistry of chalkones, III, 64.

Kapadia, M. R. *See* Prasad, Mata, M. R. Kapadia, and V. C. Thackar.

Kapoor, A. N. *See* Chowdhury, H. D., S. N. Mukerji, A. N. Kapoor, and J. S. Aggarwal.

Kapur, A. P. Bionomics of two coccinellids *Adonia variegata* Goez. and *Brumus suturalis* F. predating on aphids, III, 146.

Kapur, P. L. Angular distributions of emitted particles in nuclear reactions, III, 12.

——— Partial entry of particles through potential barriers, III, 13.

Kapur, P. L. *See* Bhatnagar, S. S., P. L. Kapur, and A. Hussain; also Bhatnagar, S. S., P. L. Kapur, and M. S. Hashmi.

Kapur, S. L. *See* Sarin, J. L., and S. L. Kapur.

Karachi Air Port, Drigh Road—Fog at, III, 18.

Karachi—Diurnal variation in the temperature and humidity distribution up to 3 km. over, III, 17.

Karachi—Experimental aeroplane soundings with meteorograph over, III, 17.

Karim, S. Mujtaba, Lal C. Verman, and S. V. Anantakrishnan. Thermal endurance of electric lamp glass bulbs, III, 32.

Karimullah, N. Ghatak, J. S. Aggarwal, and Lal C. Verman. Utilization and properties of rice bran and oil derived from it, III, 92.

Karmakar, G. *See* Datta, S., and G. Karmakar.

Karve, D. D., and D. V. Gharpure. Hydrolysis of some aromatic and aliphatic nitriles by sulphuric acid, IV, 5.

Karve, D. D., and V. L. Mehendale. Hydrolysis of esters in heterogeneous systems, IV, 4.

Kaura, R. L., and S. Ganapathy Iyer. A successful method of vaccination against goat-pox, III, 178.

Kaura, R. L., and S. Ganapathy Iyer. Biochemical classification of streptococci associated with strangles in India, III, 172.

Kaura, R. L. Daily variations in the serum protein fractions of buffaloes undergoing immunization by various methods against rinderpest and their relation to the potency of the serum, III, 177.

——— Infectivity of eggs in Doyle's (Ranikhet) disease, III, 178.

——— Rinderpest in sheep in India, III, 179.

——— The value of synthetic media in the preparation of mallein, III, 172.

Kazim, Syed, and C. Mahadevan. The age of some metamorphosed sedimentary rocks in parts of Warangal District, Hyderabad State, III, 108.

Kehar, N. D., and Mohan Singh. Normal clinical standards of equine blood, III, 176.

Kehar, N. D. Blood chemistry of normal and hæmaturia animals, III, 180.

——— Observations on avitaminosis-A in farm animals and how it is brought about, III, 177.

——— The association of aphosphoresis with contagious equine abortion, III, 180.

Khan, C. A. *See* Banerji, A. D., C. A. Khan, and Lal C. Verman.

Khanna, K. L., and P. C. Raheja. A note on the relative efficiency of water requirements in relation to manurial treatments, IV, 8.

Khanna, K. L., and R. R. Panje. Seasonal shoots in sugarcane, IV, 9.

Khastgir, S. R., and Shah Md. Fazlor Rahman. The dielectric constant and electrical conductivity of gases and vapours ionized by X-rays at ultra-high radio frequency, III, 24.

Khastgir, S. R., and Shah Md. Fazlor Rahman. The ultra-high frequency dielectric constant and electrical conductivity of ionized air in a discharge tube, III, 24.

Kichlu, P. K., and B. M. Anand. Absorption of bismuth vapour between 600Å and 900Å, III, 21.

Kichlu, P. K., and B. M. Anand. Absorption spectrum of cadmium by the excitation of inner electrons, III, 21.

Kichlu, P. K. Continuous spectrum of helium, III, 21.

Kini, M. G. The treatment of dislocations of elbow and its complications with a simple technique for excision of elbow, III, 167.

Kishen, K. On a general method of constructing the appropriate compounds in terms of the twelve 3×3 Latin squares for any of the eight components $N_1 K_1 P_1$, $N_1 K_1 P_2$, $N_1 K_2 P_1$, etc., of the second order interaction in a 3×3×3 factorial arrangement, III, 199.

Kishen, K. *See* Bose, R. C., and K. Kishen.

Kishen, (Mr.) K. *See* Bose, (Mr.) R. C., and (Mr.) K. Kishen.

Kishen, K. Split-plot technique in field experimentation, III, 199.

Koteswaram, P. Association in formic acid, III, 27.

Koteswaram, P. Continuous spectrum in Raman effect, III, 28.

Kothari, D. S., and B. N. Singh. The equilibrium between neutrons, protons, and electrons, III, 11.

Kretschmer's theory and Behaviorism, III, 227.

Krishnagar, Bengal—Geography of the town of, III, 109.

Krishnamurthi, P. S. *See* Cherian, M. C., M. S. Kylasam, and P. S. Krishnamurthi.

Krishnamurthi, T. N. *See* Anantakrishnan, S. V., and T. N. Krishnamurthi.

Krishnamurthy, C. *See* Guha, P. C., and C. Krishnamurthy.

Krishnamurthy, L. S. *See* Mukherjee, S. K., and L. S. Krishnamurthy.

Krishnamurty, P. V. *See* Rao, W. V. B. Sundara, P. V. Krishnamurty, and G. Gopalarao.

Krishnamurty, S. G., and R. Sanjivarao. The higher spark-spectra of iodine I(V), III, 21.

Krishnan, B. G. Calorie requirements of South Indian Children, III, 164.

Krishnan, (Prof.) B. T., IV, 46.

Krishnan, (Prof.) K. S., IV, 14.

Krishnan, K. S., A. Mookherji, and A. Bose. Paramagnetic studies on single crystals, IV, 3.

Krishnan, K. S., and A. Mookherji. Temperature variation of the magnetic anisotropy of $CuSO_4 5H_2O$, IV, 3.

Krishnan, K. S., and N. Ganguli. The structure-sensitiveness and the temperature-dependence of the abnormal unidirectional diamagnetism of graphite crystal, IV, 3.

Krishnan, R., and S. K. K. Jatkar. Equilibrium in electrodeless discharge, III, 56.

Krishnaswami, K. R. *See* Rao, S. Gopala, and K. R. Krishnaswami; also Shah, B., and K. R. Krishnaswami; also Subbaraman, P. R., and K. R. Krishnaswami; also Sastri, M. V. C., and K. R. Krishnaswami.

Krishnaswami, T. Recent irrigational changes and their effects in Grand Ancient Canal Region (Tanjore), III, 111.

Kulkarni, B. S., and S. K. K. Jatkar. Dehydration of fuller's earth, III, 53.

Kulkarni, D. R., N. M. Shah, and R. L. Alimchandani. Studies in coumarins, III, 64.

Kumria, (Mr.) R. R., IV, 53.

Kuriyan, George. Sugarcane cultivation in India, III, 111.

Kurupp, N. K. B. T.E.B. 1, an alkali-resistant strain of paddy for Nanjinad, III, 181.

Kurupp, N. K. B. Varieties of mangoes cultivated in Travancore, III, 182.

Kylasam, M. S. *See* Cherian, M. C., M. S. Kylasam, and P. S. Krishnamurthi.

L

Lac—On the specific heat of, III, 34.
Lal, Brij Mohan. The lumbo-sacral plexus and the innervation of muscles in primitive mammals, III, 216.
Lal, K. B. Some Indian ants of economic importance and some methods of their control, III, 194.
——— Some new parasitic Hymenoptera from India, III, 141.
Lal, P. C. Teacher and his make-up, IV, 11.
Lander, (Dr.) P. E., IV, 43.
Lands seasonally water-logged—Utilisation of, III, 111.
Language—Psychological study of, III, 221.
Latif, (Dr.) I., IV, 54.
Latif, I. A contribution to the study of conversion hysteria, III, 229.
Leaf spots of *Agave americana* Linn. caused by *Diplodia agaves*, IV, 5.
Lectures and demonstrations—Special, I, 17.
Lectures—Popular, I, 17.
Limaye, S. D. Extension of the Nidhone process for the syntheses of 2-acyl-resorcins to 2-acyl-4-alkyl-resorcins. Part I. Synthesis of 2-acetyl-4-ethyl-resorcin, III, 73.
Linderstrom-Lang, K. *See* Sreenivasaya, M., and Linderstrom-Lang.
Linguistic divisions—Ethnological and, II, 183.
Liver concentrate—On the activity of, III, 214.
Longevity of coliform organisms in water stored under natural conditions, III, 162.
Loomba, R. M. Kretschmer's theory and Behaviourism, III, 227.
Lumbo-sacral plexus and the innervation of muscles in primitive mammals —The, III, 216.
Luminescence of phosphorus under electric discharge, III, 59.
Lunar diurnal variation field—The, II, 24.
Luthra, J. C., and I. S. Chima. Some studies on the potentiality of imperfectly developed wheat grains, III, 189.
Luthra, J. C., and I. S. Chima. Studies on the metabolism and growth of Malta oranges, III, 183.
Luthra, (Rai Sahib) Jai Chand, IV, 30.

M

Madan, N. S. Leaf spots of *Agave americana* Linn. caused by *Diplodia agaves*, IV, 5.
Madan, N. S. *Pestalozzia Phoenicis* on *Phoenix dactylifera*, IV, 6.
Madhava, (Prof.) K. B., IV, 16.
Madhok, (Dr.) M. R., IV, 43.
Magnetic disturbances associated with radio fade-outs—Evidence from, II, 31.
Magnetic field and its harmonic analysis—The Earth's permanent, II, 19.
Magnetic field and their analysis—The Solar diurnal variations of the earth's, II, 22.
Magnetic storms, II, 33.
Magnetic storms—Cause of, II, 37.
Magnetic susceptibilities of solutions of sodium and potassium nitrate, III, 44.
Magnetism and the Upper Atmosphere—The Earth's, II, 19.
Magnetism and molecular constitution of some chromium compounds, III, 43.
Magneto-chemical investigation of the photo-halides of silver, III, 45.
Mahadevan, C. *See* Kazim, Syed, and C. Mahadevan.

Mahadevan, C. Some sedimentary structures in the Manglur Band of Dharwars, III, 106.

———— Sub-artesian effect at Yedrami, Andola Taluq of Gulberga District, III, 103.

Mahadevan, (Miss) G. *See* Aiyar, R. Gopala, and (Miss) G. Mahadevan.

Mahajan, M. R. The importance and control of freshwater snails in veterinary research with special reference to work in Hyderabad State, III, 175.

Mahalanobis, (Prof.) P. C., IV, 14, 23.

Mahalanobis, P. C. A note on grid sampling, III, 7.

Mahalanobis, P. C. *See* Nair, K. R., S. C. Chakravarti, and P. C. Mahalanobis.

Mahanty, R. *See* Sen, D. N., and R. Mahanty.

Maiti, H. P., III, 219.

Maiti, (Mr.) H. P., IV, 26, 52, 55.

Maiti, H. P. Dynamic structure of the human personality, II, 341.

Maitra, J. N. Further observations on 'coronary occlusion', III, 162.

———— Psychology of cardiac pain, its relation to sudden death and its anatomical basis, III, 233.

Majumdar, B. *See* Chakravarti, D., and B. Majumdar.

Majumdar, D. N., III, 149.

Majumdar, (Dr.) D. N., IV, 21, 22, 23, 24, 57.

Majumdar, D. N. *See* Singh, Kr. Indrajit, and D. N. Majumdar.

Majumdar, D. N. Tribal cultures and acculturation, II, 179.

Majumdar, N. K. Instincts in Psycho-analysis, III, 229.

Making of a 6" long focus (15') achromatic objective—The, IV, 4.

Mal, (Prof.) Bahadur, IV, 57.

Malaria in buffaloes—observations on, III, 170.

Malhotra, K. L. Morphology of the ossicula auditus in the hedgehog (*Erinaceous collaris*) and the house-shrew (*Crocidura caerulea*), III, 137.

Malik, Ghulam Mustafa. The food of the Mountain Barbel *Orienus* McClelland, and its probable bearing on the introduction of brown trout in Himalayan streams, III, 136.

Mallik, A. K. A study of transpiration in relation to meteorological factors, III, 201.

Mallik, A. K. *See* Ramdas, L. A., and A. K. Mallik.

Mallik, A. K. The invisible condensation of water vapour on the soil and on plant materials like stalk, leaves and grain, III, 201.

Malurkar, S. L. A study of stability of atmospheric strata, III, 16.

Mandal, K. L. *See* Neogi, P., and K. L. Mandal.

Mangoes cultivated in Travancore—Varieties of, III, 182.

Mani, M. S. Growth and respiration in the galls of *Asphondylia riveae* Mani and *Odinadiplosis odinae* Mani (Itonididæ: Diptera), III, 141.

Margabandhu, V. *See* Ayyar, P. N. Krishna, and V. Margabandhu.

Mathematics and Physics—Section of, II, 19; III, 1.

Mathen, (Miss) Mary. *See* Rao, B. Sanjiva, and (Miss) Mary Mathen.

Mathur, K. G. Study of pectin content of bagasse, III, 97.

Mathur, K. N. *See* Prasad, Mata, and K. N. Mathur.

Mathur, S. B. A note on the method of parallax and the resolving power of the eye, IV, 4.

Mathur, S. N. Note on the duration of the activity of salivary enzymes on cloth, III, 208.

Mathur, S. N. Range of systolic blood pressure in healthy young students, III, 205.

Mazumdar, A. *See* Basu, U. P., and A. Mazumdar.

Median statistic in tests by randomization—The use of, III, 9.

Medical and Veterinary Research—Section of, II, 225; III, 157.

Medical Research, III, 157.

Medical Science—The future progress of, II, 268.

Medical Sciences—Ancient Hindu, II, 231.

Medicine and pathology, III, 157.

Medicine in India in the middle of 16th century, III, 169.
Meeting of General Committee, I, 28.
,, ,, ,, Special, I, 35.
Meeting of the Council, I, 35.
Meetings of the Executive Committee, I, 37.
Mehendale, V. L. *See* Karve, D. D., and V. L. Mehendale.
Mehrotra, S. N. *See* Misra, A. B., and S. N. Mehrotra.
Mehta, T. N., and V. B. Thosar. Estimation of members of naphtol AS series, III, 99.
Mehta, T. N., and D. M. Trivedi. Synthetic textile auxiliaries. Part I. α-sulphonates of fatty acids and their substituted amides, III, 76.
Mehta, T. N., and D. M. Trivedi. Synthetic textile auxiliaries. Part II. α-pyridininium. Compounds of fatty acids and their substituted amides, III, 77.
Mehta, T. N., and V. B. Thosar. The reaction of some aromatic diamines with ethyl malonate, III, 72.
Mehta, T. N. *See* Dalal, N. M., and T. N. Mehta.
Members—Associate Session, IV, 88.
Members—Full Session, IV, 81.
Members—Ordinary, IV, 58.
Members—Student Session, IV, 91.
Menon, A. Karunakara. Fisheries of Cochin, III, 110.
Menon, A. Karunakara. Utilisation of lands seasonally water-logged, III, 111.
Menon, K. Padbhanabha. Staphylococcus aureus in vaccine lymph, III, 163.
Menon, T. C. R. The Kabadi system in Bastar State, III, 154.
Mental diseases among the primitive people, III, 152.
Mental qualities—Measurement of, III, 225.
Menzel, Emil W. Measurement of mental qualities, III, 225.
Mercury arc lamps of exceedingly long life and made of soft glass, III, 27.
Metabolism—Alimentation and, II, 326.
Metabolism and growth of Malta oranges—Studies on the, III, 183.
Metabolism of calcium and phosphorus in human beings, III, 211.
Mineral industries—Revival of certain forgotten, II, 89.
Mineral Wealth—Conservation of India's, II, 65.
Minerals—Conservation of Fuel, II, 67.
Minerals—Conservation of other, II, 83.
Minerology and Petrology, III, 104.
Misra, A. B., and S. N. Mehrotra. On the occurrence and production of abnormal spermatozoa in the pigeon, III, 137.
Misra, A. B. On the secretion of the ovisac by the female of *Drosichiella* (*Monophlebus*) *quadricaudatus* and its structure, III, 143.
Misra, R. N. *See* Pande, S. K., and R. N. Misra.
Misra, R. N. Studies in Indian hepaticæ, II. On the epiphyllous liverworts of India, III, 119.
Mitra, A. K., and B. K. Chatterjee. Racial affinities of the Hindu population of Orissa, III, 149.
Mitra, A. N. Studies in the flagellates (Mastigophora) found in the intestines of the common Indian snakes, III, 129.
Mitra, B. N. Oxidation-reduction potentials of *Vibrio Choleræ* and related organisms, III, 96.
Mitra, D. D., and G. Sankaran. Applicability of Rotter's test in field investigations in the determination of vitamin C deficiency, III, 214.
Mitra, K. Nutrition studies in Bihar, I. (Dietary habits of the College students at Patna), III, 210.
Mitra, K. Nutrition studies in Bihar. Part II. Chemical composition of some of the local edibles, III, 94.

Mitra, R. P., and S. Chakravarty. Variations in the properties of hydrogen clays obtained from different clay subfractions of Indian soils, III, 184.

Mitra, S. C., and A. Datta. The influence of colour on the estimation of area, III, 220.

Mitra, S. C. On certain expansions involving Bessel functions, III, 3.

Mitra, S. K. The fringe of the outer atmosphere, III, 13.

Mitra, S. M. Influence of a fluorescent dyestuff molecule on the polarization of fluorescence of another dyestuff in solution, III, 28.

Mitra, S. M. On the influence of foreign substances on the absorption of the dyestuffs in solution, III, 29.

Mitter, P. C., and Lakshmikanta De. Condensation of methyl succinic anhydride with phenolic ethers, III, 60.

Modak, K. V. *See* Prasad, Mata, and K. V. Modak.

Modern Geographer in India—Rôle of the, IV, 16.

Mohsin, S. M. A psychoanalytical theory of play, III, 232.

Molybdenum electrode, III, 47.

Monascus occurring in orange-squash—A study of, III, 118.

Monsoon rains in Bombay—Changes of atmospheric electric potential gradient associated with, III, 17.

Mookerjee, H. K., and (Mrs.) S. Das. On the development of the vertebral column of *Lepidosteus osseus*, III, 135.

Mookerjee, S. P. *See* Raichoudhury, D. P., and S. P. Mookerjee.

Mookerji, R. R. A description of the Nicobarese rat-trap, III, 154.

Mookherji, A. *See* Krishnan, K. S., A. Mookherji, and A. Bose; also Krishnan, K. S., and A. Mookherji.

Morphology of the larval forms of *Hypoderma crossii*—Studies upon the, III, 176.

Moses, S. T. The recent placuna pearl fishery in Baroda and some notes on the window-pane oyster, III, 131.

Moses, S. T. The Vaghers of Okhamandal, III, 150.

Motion—Uniform—of a sphere or a cylinder through a viscous liquid, III, 6.

Mukerjee, R. K. Taboo and discipline of sex and family, III, 151.

Mukerji, B., and N. K. Iyengar. Correlation between chemical constitution, pharmacological action and enzymatic breakdown of certain adrenalinlike amines, III, 215.

Mukerji, B., and R. Ghosh. Estimation of conjugated glucoronic acid as a test for liver function, III, 208.

Mukerji, B., and R. N. Chopra. Studies on some dextro-rotatory hydrocupreidine derivatives. Part III. Action on *Paramoecium caudatum* III, 214.

Mukerji, B. *See* Iyengar, N. K., and B. Mukerji.

Mukerji, D., and S. B. Pal. On the reproductive system of the silkworm, *Bombyx mori* L, III, 145.

Mukerji, S. N. *See* Chowdhury, H. D., S. N. Mukerji, A. N. Kapoor, and J. S. Aggarwal.

Mukherjee, G. C. Effects of (i) repetition of a single stimulus, applied directly or indirectly at an interval of 2 minutes, (ii) repetition of two successive stimuli under nearly the same conditions, and (iii) rapidly successive stimuli to frog's nerve-muscle preparation immersed in a solution of adrenalin or acetyl-choline in (*a*) Ca-free Ringer, or (*b*) K-free Ringer, or (*c*) Ringer, or (*d*) modified Ringer with varying concentrations of Ca or K, III, 204.

Mukherjee, N. This 'Factory' of Factorial School, III, 223.

Mukherjee, N. Some aspects of measurement of Intelligence, III, 226.

Mukherjee, P. N. *See* Bagchi, K. N., H. D. Ganguli, and P. N. Mukherjee.

Mukherjee, S. K., and L. S. Krishnamurthy. A few observations on the stratigraphical sequence of some of the Purana sedimentaries, North Krishna Basin, Nalgonda District, Hyderabad State, III, 107.

Mukherjee, S. N. Cataphoretic velocity and surface condition of polymorphonuclear leucocytes from rabbits suspended in different media, III, 94.

Mukherji, A. The vitamin B-complex in toxic conditions, III, 212.

Mukherji, B. *See* Iyenger, N. K., and B. Mukherji.

Mukherji, (Dr.) B. K., IV, 44.

Mukherji, K. C. The importance of visual image in tactual localization, III, 219.

Mukherji, (Mr.) K. C., IV, 25.

Mukherji, Sankaranand. *See* Joshi, S. S., and Sankaranand Mukherji.

Mulay, B. N., and G. D. Bhavani. Observations on the vegetation found round about Laki and Manga Pir—two hot springs in Sind, III, 126.

Mulay, B. N. Fertilization in *Azolla pinnata*, R.BR., III, 120.

Mulay, B. N. Some ecological observations on the life history of Azolla pinnata, R.BR., III, 126.

Mulay, B. N. Some observations on the Microsporocarps, Microsporangia and the male prothallium of Azolla pinnata, R.BR., III, 119.

Mulchandani, B. B. Effect of soaking on germination of cotton seed, III, 181.

Mulchandani, B. B. Note on the tolerance of different types of cotton to alkaline soils in Sind, III, 181.

Mullick, D. N. Estimation of inorganic phosphorous by absolute colorimetry, III, 209.

Mundkur, B. B. Taxonomic studies of Indian smuts, III, 115.

Murthi, K. Narayana. Epidemiology of infantile cirrhosis, III, 158.

Murthi, K. Narayana. Infantile cirrhosis (a case report), III, 157.

Murthi, K. Narayana. *See* Tirumurti, T. S., and K. Narayana Murthy.

Murthy, V. V. S., and Y. V. S. Rau. Estimation of calcium in different varieties of rice by two methods, III, 99.

Murthy, V. V. S. *See* Rau, Y. V. S., and V. V. S. Murthy.

Murti, G. V. L. Narasimha. The behaviour of organic solids on the surface of water, III, 48.

Muthanna, M. S. *See* Guha, P. C., and M. S. Muthanna.

Mystic life—Sensory aid in, III, 229.

N

Nagaratna, Srimati B. A study of Anger in Children, III, 232.

Naidu, D. S. *See* Joglekar, G. D., K. Subba Ramaiah, D. S. Naidu, and Lal C. Verman.

Naidu, P. S. A reconstruction of the Hormic theory of sentiments, III, 222.

Naik, K. G., R. K. Trivedi, and H. P. Parikh. Studies on the substituted amides cynacetic acid. Part I. Velocity of saponification of the substituted amides of the cyanacetic acid of the type: $CN.CH_2$ CONHR, III, 67.

——————Studies on the substituted amides of the cyanacetic acid. Part II. Preparation of the chloro derivatives of the substituted amides of cyanacetic acid, III, 68.

——————Part III. The velocity of the replacement of the chlorine atoms by hydrogen in the compounds of the type $CN\text{-}CCl_2\text{-}CONHR$, III, 68.

Naik, R. N. Rinderpest in sheep and goats in the Province of Bombay, IV, 8.

Naik, Y. G. *See* Tawde, N. R., Y. G. Naik, and V. D. Desai.

Nair, K. R., S. C. Chakravarti, and P. C. Mahalanobis. A 10 × 10 quasi-factorial experiment at Chinsurah with 100 strains of rice, III, 199.

——————Some balanced confounded arrangements for the 5^n type of experiment, III, 200.

Nair, K. Raghavan. Tables of confidence intervals for the median in samples from any continuous population, III, 9.

—————— The use of median statistic in tests by randomization, III, 9.

Nair, V. Govindan, and V. V. Chetty. Chemotherapy and lymphogranuloma inguinale, III, 158.
Nair, V. Govindan, and V. V. Chetty. Uleron in the treatment of gonorrhœa, III, 159.
Nandi, H. K., and P. M. Ganguli. Some observations on rice seed-testing, III, 182.
Nandy, A. B. *See* Raychaudhuri, S. P., and A. B. Nandy.
Narain, Raj. Sensory aids in mystic life, III, 229.
——— The culture of emotions in mystic life, III, 230.
Narang, K. S., and J. N. Ray. Rottlerin. Part IV, III, 64.
Narang, K. S. *See* Duegan, B. S., K. S. Narang, and J. N. Ray.
Narasimhan, V. *See* Joshi, S. S., and V. Narasimhan.
Narasimharao, M., and G. Sankaran. Sub-clinical Vitamin A deficiency studied by a photometer, III, 211.
Narayana, (Dr.) B., IV, 48.
Narayana, B. Action of drugs on the coronary flow, III, 215.
Nath, (Mr.) B. Viswa, IV, 27.
Nath, (Rao Bahadur) B. Viswa, IV, 38.
Nath, M. C. A note on some modifications of Pregl's method for the microanalytical determinations of carbon and hydrogen in the humid atmosphere of tropical summer, III, 98.
Nath, Raj, and P. N. Ganjoo. Study of Panjal Traps in the neighbourhood of Srinagar, Kashmir, III, 105.
Nature and range of insect injury and incidence, II, 284.
Nawkal, H. *See* Sukthankar, S. S., N. Ahmad, and H. Nawkal.
Nayar, G. K. *See* Joshi, S. S., and G. K. Nayar.
Nayar, M. R. Temperature coefficient of conductivity of an aq. solution of iodic acid, III, 45.
Nazimuddin. *See* Banerji, A. C., Nazimuddin, and P. L. Bhatnagar.
Nebula—The arms of a spiral, III, 11.
Neogi, P., and K. L. Mandal. Experiments on resolution of co-ordinated inorganic compounds. Part III. Co-ordinated copper compounds with propylene diamine, III, 37.
——— Pectic change and organic acids in fruits. Part I, III, 96.
——— Resonance reactions. Part II, III, 38.
Neogy, R. Free and total ascorbic acid content of some common Bengali foods before and after cooking, III, 213.
Neutrons, protons, and electrons—The equilibrium between, III, 11.
New Education movement—Psychology of the, III, 224.
Nigam, L. N. *See* Pruthi, H. S., and L. N. Nigam.
Nijhawan, K. K. *See* Sarin, J. L., and K. K. Nijhawan.
Non-linear integral equations—Further contributions to the theory of, III, 1.
Normal clinical standards of equine blood, III, 176.
Normal modes—The application of group-characters for the determination of, III, 1.
Nuclear reactions—Angular distributions of emitted particles in, III, 12.
Nutrition, III, 164.
Nutrition—Dietetics and, II, 327.
Nutrition studies in Bihar, I. (Dietary habits of the College students at Patna), III, 210.

O

Observations on avitaminosis-A in farm animals and how it is brought about, III, 177.
Observations on rice seed-testing—Some, III, 182.
Occurrence of equine nasal bot, *Rhinoestrus purpureus* (Brauer, 1858) in India—The, IV, 8.
Officers of the Indian Science Congress Association for 1938-39, I, 6.
Officers of the twenty-sixth Congress, I, 3.

Oils—Catalytic polymerization of, III, 93.
Oils—Sulphocyanide value of, III, 94.
Optical silvering on glass by the chemical method and the critical rôle of the extent of surface, III, 35.
Outer atmosphere—The Fringe of the, III, 13.

P

Pal, Gopeswar. D.L. for lifted weights by the method of continuous increase of the standard, III, 219.
Pal, H. K. A study of the energy distribution of scattered X-radiation, IV, 2.
——— A study on the polarisation of X-rays, IV, 2.
——— Absorbability of scattered X-rays, IV, 1.
Pal, H. N. Effects of alphos on sugarcane grown in an acid soil, III, 186.
Pal, (Dr.) R. K., IV, 48.
Pal, S. B., and H. L. Sarkar. On the nervous system of silk-worm, *Bombyx mori* L, III, 145.
Pal, S. B. *See* Raichoudhury, D. P., and S. B. Pal; also Mukerji, D., and S. B. Pal.
Palæobotany, III, 127.
Palæontology—Stratigraphy and, III, 107.
Palit, S. R. Electrochemistry of resin solutions, III, 45.
Pande, S. K., and R. N. Misra. Studies in Indian hepaticæ. I. On two new species of *Leptocolea* S. from the Western Himalayas, III, 119.
Pande, S. K., and T. N. Srivastava. Studies in Indian hepaticæ. III. On a new species of *Nowellia*; *N. indica* Pande et Srivastava, from the Western-Himalayas, III, 119.
Pandya, K. C., and T. S. Sodhi. Condensation of protocatechuicaldehyde with malonic acid in the presence of organic bases. Synthesis of caffeic acid, III, 61.
Pandya, K. C. *See* Singh, D. B., and K. C. Pandya.
Panje, R. R. *See* Khanna, K. L., and R. R. Panje.
Panse, T. B., and T. S. Wheeler. Benzylidene-coumaranones considered as chalkones, III, 68.
Papainases—Natural activator of, III, 206.
Parallax and the resolving power of the eye—A note on the method of, IV, 4.
Paralysis in a pigeon due to Doyle's (Ranikhet) disease, III, 179.
Paramagnetic studies on single crystals, IV, 3.
Parameswaran, H., and A. V. V. Krishna Rao. The making of a 6″ long focus (15′) achromatic objective, IV, 4.
Parameswaran, H., and S. Hariharan. The figuring of a 24″ reflector made in India, IV, 3.
Paraphagistic on the Indian domestic fowl (*Gallus bankiva murghi*)—On a new feather mite, IV, 8.
Parija, P., and B. Samantarai. March of transpiration of a leaf from the earliest stage to its fall, III, 126.
Parikh, H. P. *See* Naik, K. G., R. K. Trivedi, and H. P. Parikh.
Parmar, Y. S. Marital life in the Transgiri tract, III, 151.
——— Some aspects of the material economy of Transgiri people, III, 150.
Parsram, (Mr.), IV, 54.
Parsram. Fear and anger responses of adults, III, 221.
——— On the questionnaire method in Psychology, III, 222.
Partial fractions in determinantal forms—Generalizations on, III, 4.
Pasteurellosis in white mice, III, 173.
Pathological Anatomy—A Brief History of, II, 247.
Pathology—A brief account of the history of, II, 225.
Pathology—Clinical, III, 170.
Pathology in General, II, 254.

Pathology—Medicine and, III, 157.
Pathology of the gastro-intestinal tract in cholera—Studies in the, III, 161.
Patrons, I, 3, 12.
Pectin content of bagasse—Study of, III, 97.
Pellagra in Madras Presidency. Twenty-one cases of pellagra with treatment of five cases by nicotinic acid, III, 159.
Permanent magnetic field and its harmonic analysis—The Earth's, II, 19.
Personality in a biological perspective—Dynamic theory of, II, 348.
Personality—Need for a dynamic concept of, II, 344.
Personality of India—The Geographical, II, 99.
Personality—Psychiatry and problem of, II, 342.
Personality—Psychoanalytic theory of, II, 346.
Personality structure and society, II, 359.
Personality tests, II, 342.
Pest outbreaks and factors influencing them, II, 282.
Pestalozzia phoenicis on *Phoenix dactylifera*, IV, 6.
Peter, H.R.H. Prince. The utility of Psycho-analysis in social Anthropology, III, 230.
Petrology—Minerology and, III, 104.
Pharmacology, III, 214.
Phoenix dactylifera—Pestalozzia phoenicis on, IV, 6.
Phosphine under electrical discharge—Decomposition of, III, 39.
Phosphorus and calcium in rice—Studies on the availabilities of, III, 166.
Photographs of regions in the Milky Way, taken with a short focus camera —Some, III, 10.
Photohalides of silver—A magnetic investigation of the, III, 33.
Photosensitizing dyes. The influence of anions on the properties of dyes derived from α-picoline, III, 83.
Phototropy and photochemical isomerism from the magnetic standpoint, III, 54.
Physics of the Atmosphere and Meteorology, III, 13.
Physics—Section of Mathematics and, III, 1.
Physiographic Divisions of India—A Need for Uniformity in the, IV, 18.
Physiological research in India, II, 317.
Physiological research in India—Review of progress of, II, 322.
Physiology and Ecology, III, 125.
Physiology—General, III, 203.
Physiology in General Education—The Place of, IV, 46.
Physiology—Scope of research in, II, 318.
Physiology—Section of, II, 317; III, 203.
Pichamuthu, C. S. On fibrous quartz from the Bababudan Hills, Mysore State, III, 104.
——— On the petrology of the felside of Galipuje, Mysore State, III, 105.
Pillai, A. R. Changes of atmospheric electric potential gradient associated with monsoon rains in Bombay, III, 17.
Pillai, M. J. S. Serology in Radiation Therapy, IV, 7.
Pirie, N. W. *See* Sreenivasaya, M., and N. W. Pirie.
Pithawalla, (Mr.) B. M., IV, 18.
Pithawalla, Maneck B. Potential spas of Sind, III, 112.
——— Problems of Greater Karachi—geographical solution through forming satellite towns in 12-mile circle, III, 112.
Polarization of fluorescence of another dyestuff in solution—Influence of a fluorescent dyestuff molecule on the, III, 28.
Pollination, and the phenomena connected with it in *Eugenia jambolana*—Observations on the, III, 124.
Population—Tables of confidence intervals for the median in samples from any continuous, III, 9.
Positive bands in higher temperature arc—First, III, 23.
Positive ray tube—'Chemical clean up' in a, III, 25.

Positive ray tube—Localisation of a discharge in a, III, 25.
Possibilities of cattle fly sprays in India—The, III, 174.
Post-Hippocratic medicine of Alexandria, II, 240.
Potassium permanganate from Indian raw materials—Synthesis of, III, 40.
Potassium salt of a new borohydrate—On the, III, 38.
Potato tuber—A study on the rate of respiration in relation to nitrogen metabolism of, III, 125.
Potential function for two bodies—Levi-Civita's, III, 10.
Potential gradient associated with monsoon rains in Bombay—Changes of atmospheric electric, III, 17.
Potentiality of imperfectly developed wheat grains—Some studies on the, III, 189.
Pradhan, S. A neuro-muscular study of the mouth-parts of *Coccinella septempunctata* with a comparison of the mouth-parts in some Indian Coccinellids, III, 139.
——— Glands in the head-capsule of Coccinellid beetles with a discussion on some aspects of gnathal glands, III, 139.
Pranavananda, Swami. The Source of the Brahmaputra, III, 112.
Prasad, B. *See* Srinivasan, M. K., and B. Prasad.
Prasad, Kali. Psycho-analytical theory of meaning. Part I, III, 221.
Prasad, Mata, and C. R. Talpade. Photo-reduction of ferric chloride in the presence of acetaldehyde, III, 53.
Prasad, Mata, and K. N. Mathur. Studies in gels of sodium oleate, III, 51.
Prasad, Mata, and K. N. Rao. Studies in the heterogeneous reaction between chromium oxide and potassium permanganate, III, 54.
Prasad, Mata, and K. V. Modak. Studies in coagulation and gelation by viscosity and opacity measurements, III, 51.
Prasad, Mata, M. R. Kapadia, and V. C. Thackar. An X-ray investigation of the crystals of *o*- and *p*-nitrobenzoic acids, III, 59.
Prashad, (Dr.) Baini, IV, 20.
Predissociation in the bands of CuCl, III, 22.
Preference for school subjects—Pupils', III, 226.
President, I, 3.
Presidential Addresses—Sectional, I, 15.
Presidents of Sections, I, 3.
Proceedings—Opening, I, 21.
Production of hydrogen Lyman series, III, 22.
Properties of hydrogen clays obtained from different clay subfractions of Indian soils—Variations in the, III, 184.
Protons, and electrons—The equilibrium between neutrons, III, 11.
Protozoology, III, 171.
Pruthi, (Dr.) H. S., IV, 27.
Pruthi, H. S., and L. N. Nigam. The *ak* grasshopper (*Poecilocerus Pictus* F) as a pest of cultivated crops, III, 194.
Pruthi, H. S. Records of some insects from a hot spring in the Kulu Valley, Punjab, III, 138.
Psychiatry and problem of personality, II, 342.
Psycho-analysis and Psychiatry, III, 227.
Psycho-analysis in social anthropology—The utility of, III, 230.
Psychoanalytic theory of personality, II, 346.
Psychoanalytical study on marriage—A, III, 227.
Psycho-analytical theory of meaning. Part I, III, 221.
Psycho-ethics: ancient and modern, III, 222.
Psychological investigation of insane murders, III, 227.
Psychology and its effect on creative literature—New, IV, 10.
Psychology—Categories and concepts in, III, 223.
Psychology—Child, III, 232.
Psychology in the service of Education in India, IV, 52.
Psychology—Physiological, III, 233.
Psychology—On questionnaire method in, III, 222.

Psychology—Section of, II, 341; III, 219.
Psychology—Social, III, 229.
Pteridophyta, III, 119.
Punjab—Rainfall in the, III, 17.
Pure Mathematics, III, 1.
Puri, (Dr.) A. N., IV, 41.
Puri and adjoining areas, Orissa—Geography of, III, 109.
Puri, G. S. The Pleistocene flora of Kashmir, Part (I), III, 127.
Puri, V. Studies in the order Parietales II. A contribution to the morphology of *Garcinia livingstonii* T. Anders, III, 120.
Puri, V. S., and F. R. M. Alvi. Effect of inorganic colloids on the electro-deposition of nickel on iron, III, 48.
Purushotham, A. Preparation of a simple form of high vacuum grease, III, 94.
Purushotham, A. *See* Joshi, S. S., and A. Purushotham.
Purushotham, A. Studies in active nitrogen. Part IV, III, 42.
——— ——— Part V. Wall effect, III, 43.
Pyrene—Synthesis of, III, 79.

Q

Quadric—On the axial lines of a, III, 2.
Qureshi, M., and M. A. Hai. Diamagnetic susceptibility of chlorohydrate, III, 44.

R

Radiation on radiation—On the gravitational influence of, III, 12.
Radiation Therapy—Serology in, IV, 7.
Radio fade-outs—Evidence from magnetic disturbances associated with, II, 31.
Raghavachari, K. *See* Banerji, P. C., and K. Raghavachari.
Raghavachari, K. *See* Ray, H. N., and K. Raghavachari.
Raghavachari, T. N. S., and K. Venkataramanan. Endemic fluorosis in the Province of Madras, III, 158.
Raghavachari, T. N. S., and P. V. Seetharama Iyer. Longevity of coli-form organisms in water stored under natural conditions, III, 162.
——— ——— The coli-aerogenes index of pollution used in water analysis, III, 163.
Raghavachari, T. N. S. *See* Iyer, P. V. Seetharama, and T. N. S. Raghavachari.
Raheja, P. C. *See* Khanna, K. L., and Raheja, P. C.
Rahimullah, M. On the so-called pyloric cæca in a marine fish *Trichiurus savala*, Cuv. and Val., III, 135.
Rahman, (Dr.) K. A., IV, 33.
Rahman, S. A. A method for recording the rate and depth of respiration in rabbits (Demonstration), III, 206.
Rai, (Miss) S. Development of the female gametophyte in *Capparis aphylla* Roth, III, 123.
——— The development of the gametophytes in *Fumaria indica* pugsley, III, 120.
Raichoudhury, D. P., and H. L. Sarkar. On the mouth-parts of the silk-worm, *Bombyx mori* L, III, 145.
Raichoudhury, D. P., and S. B. Pal. Effect of variable temperature and humidity upon different varieties of silk-worm, III, 145.
Raichoudhury, D. P., and S. P. Mookerjee. Experiments on the repeated pairings of *Bombyx mori* L, III, 145.
Rainfall in the Punjab, III, 17.
Rajagopal, K. *See* Giri, K. V., K. L. Shourie, and K. Rajagopal.
Rajagopalacharya, T. V. Ancient farming lore with special reference to South India, III, 202.

Rajagopalan, V. R., and V. R. Gopalakrishnan. Detection of anthrax in food stuffs in an outbreak among mules, III, 172.

——— ——— Pasteurellosis in white mice, III, 173.

Ram, Atma, M. A. Saboor, and Lal C. Verman. Preparation and application of liquid gold, III, 85.

Ram, Mola, P. N. Kalia, and B. M. Anand. Absorption of active-nitrogen in the Schumann region, III, 22.

Ram, (Mr.) Pars, IV, 24.

Ram, Tirath, and Tara Chand. Production of the spectra of antimony in a hot hollow cathode, III, 22.

Ramachandran, S. R., and K. Venkataraman. The constitution of oxycellulose and hydrocellulose, III, 70.

Ramaiah, K. Subba. *See* Joglekar, G. D., K. Subba Ramaiah, D. S. Naidu, and Lal C. Verman.

Ramiah, P. V., and T. Varahalu. Variations in the concentration of juice in sugarcane, III, 183.

Ramakrishnan, K. P. Vertical currents in the first few kilometers over Poona and their possible effect on the measures of upper winds made by pilot balloons assumed to rise at a known constant rate, III, 19.

Ramamurthy, K. The tanning industry in South India, III, 113.

Raman Effect, Association in Liquids and related subjects, III, 27.

Raman effect—Continuous spectrum in, III, 28.

Raman, K. S. Venkat. *See* Varma, P. S., and K. S. Venkat Raman.

Raman, P. K. The use of the hot-wire anemometer in studies of microclimates, III, 201.

Raman spectra and the structures of PCl_5 and $SbCl_5$, III, 28.

Raman spectra of camphor in different solvents, III, 27.

Raman, T. K. Pellagra in Madras Presidency. Twenty-one cases of pellagra with treatment of five cases by nicotinic acid, III, 159.

Ramanathan, K. R., III, 1.

Ramanathan, K. R., IV, 13.

Ramanathan, K. R.—The Earth's Magnetism and the Upper Atmosphere, II, 19.

Ramasarma, G. B., and B. N. Banerjee. Vitamin A and C changes in the mangoes during ripening, III, 95.

Ramaswami, L. S. Some aspects of the chondocranium of the tadpoles of *Rana afghana* and *Megophrys*, III, 136.

——— The hyo-laryngeal apparatus of *Megophrys major* Blgr., III, 137.

Ramdas, (Dr.) L. A., IV, 14.

Ramdas, L. A., and A. K. Mallik. Studies on evaporation from the surfaces of soil layers resting on a water table, III, 201.

Ramdas, L. A., and K. M. Gadre. On radiation minimum temperatures, III, 200.

Ramdas, L. A., and S. Y. Joglekar. Some experiments on the thermal repulsion of particles, III, 33.

Ramdas, L. A. The thermal structure of the air layers near the ground at night during clear weather in relation to other meteorological factors, III, 19.

Ramdas, L. A., V. Satakopan, and S. Gopal Rao. Dates of onset of the south-west monsoon on the west coast of India, III, 200.

Ranchi Plateau, Chota Nagpur—Gneissic topography of, III, 109.

Random Sample Survey—The Technique of, IV, 14.

Rangachariar, V. *See* Sen, D. N., and V. Rangachariar.

Ranganathan, S., and H. K. Sen. Shellac moulding powders, III, 90.

Ranganathan, S. *See* Bhattacharya, G. N., and S. Ranganathan.

Ranganathan, S. K. Synthesis of β-isopropyl glutaconic acid, III, 79.

Ranganathan, S. P., and M. Qureshi. Magnetic susceptibilities of solutions of sodium and potassium nitrate, III, 44.

Ranganathan, V., and Y. V. S. Rau. Effect of addition of calcium on the biological value of the proteins of Indian diets, III, 95.

Ranganathan, V. *See* Rau, Y. V. S., and V. Ranganathan.

Ranganathan, V. The availability of calcium and phosphorus in a few typical Indian diets, III, 95.

Rangaswami, M., and H. K. Sen. Manufacture of dewaxed lac, III, 89.

——— ——— Manufacture of garnet lac from by-products of lac, III, 88.

Rangaswami, S. A fine adjustment device for use with the micro-Dumas' apparatus, III, 98.

Rangaswami, S. Utilization of Indian Vegetable oils. Iodized oils, III, 92.

Rao, A. L. Sundara. Studies in soil fertility. Part II, III, 187.

——— Studies in soil fertility. Part III, III, 187.

Rao, A. V. V. Krishna. *See* Parameswaran, H., and A. V. V. Krishna Rao.

Rao, B. Sanjiva, and (Miss) Mary Mathen. Cis-trans conversion of compounds occurring in essential oils by means of selenium dioxide, III, 69.

Rao, C. J. Dasa, and N. L. Vidyarthi. Composition of the fatty acids in the glycerides of *Garcinia Indica* (Kokum butter), III, 85.

Rao, C. R. Narayan, III, 129.

Rao, (Prof.) C. R. Narayan, IV, 20, 21.

Rao, C. R. Narayan. Batrachians and their environment, II, 169.

Rao, C. V. H. On the axial lines of a Quadric, III, 2.

Rao, (Dr.) I. Ramakrishna, IV, 13.

Rao, L. Rama. On some limestones from the cretaceous rocks near Pondicherry, III, 108.

Rao, K. N. *See* Prasad, Mata, and K. N. Rao.

Rao, M. Ananta Narayan. A brief review of the species of schistosomes of the domesticated animals in India and their molluscan hosts, III, 175.

Rao, M. Narasinga. *See* Vidyarthi, N. L., and M. Narasinga Rao.

Rao, M. R. Srinivasa. Cordierites from Mysore, III, 105.

Rao, M. V. Kesava. *See* Venkatasubban, A., M. V. Kesava Rao, and M. Sreenivasaya.

Rao, (Miss) Nagamani Shama. *See* Jatkar, S. K. K., and (Miss) Nagamani Shama Rao.

Rao, P. L. Narasimha. *See* Guha, P. C., and P. L. Narasimha Rao.

Rao, P. R. Krishna. Diurnal variation in the temperature and humidity distribution up to 3 km. over Karachi, III, 17.

——— Fog at Karachi Air Port, Drigh Road, III, 18.

——— Experimental aeroplane soundings with meteorograph over Karachi, III, 17.

Rao, S. Gopal. *See* Ramdas, L. A., V. Satakopan, and S. Gopal Rao.

Rao, S. Gopala, and K. R. Krishnaswami. Elimination of titanium from a mixture of the oxides of titanium, niobium and tantalum, III, 100.

Rao, S. Rammohan. On the differentiation of sex in the first stage larva of *Drosichiella* (*Monophlebus*) *quadricaudatus*, III, 145.

——— On the internal anatomy of the first stage larva of *Drosichiella* (*Monophlebus*) *quadricaudatus*, III, 143.

——— What is the correct taxonomic status of *Monophlebus quadricaudatus* Green, III, 143.

Rao, S. Srinivas. *See* Varma, P. S., and S. Srinivas Rao.

Rao, V. E. Naganatha. *See* Thirunaranan, B. M., and V. E. Naganatha Rao.

Rao, V. N. Ranganatha. The behaviour and utility of three big bracts surrounding a flower, III, 188.

Rao, W. V. B. Sundara, P. V. Krishnamurty, and G. Gopalarao. Intermediate compounds in the biological oxidation of ammonia by nitrifying organisms, III, 96.
Rao, Y. Ramachandra, and M. C. Cherian. The control of the rice grasshopper (*Hieroglyphus banian*, Fabr.) in South India, III, 196.
Rao, Y. Ramachandra, and R. L. Gupta. Some notes on eyestripes in Acrididæ, III, 138.
Rau, Y. V. S., and V. Ranganathan. Biological value of the proteins of a few typical Indian diet, III, 95.
Rau, Y. V. S., and V. V. S. Murthy. Studies on the availabilities of phosphorus and calcium in rice, III, 166.
Rau, Y. V. S. *See* Murthy, V. V. S., and Y. V. S. Rau; also Ranganathan, V., and Y. V. S. Rau.
Ray, G. K. *See* Basu, N. M., and G. K. Ray.
Ray, H. N., and K. Raghavachari. Observations of *Babesia foliata*, n.sp. from a sheep, III, 171.
Ray, J. N. *See* Gaind, K. N., and J. N. Ray.
Ray, J. N. *See* Narang, K. S., and J. N. Ray; also Duegan, B. S., K. S. Narang, and J. N. Ray.
Ray, (Mr.) S. N. *See* Bose, (Mr.) R. C., and (Mr.) S. N. Ray.
Rây, P. R., and H. Bhattacharya. Complex compounds of biguanide with tervalent metals, cobalt phenyl-biguanide and its salts, III, 37.
Rây, P. R., and P. N. Bagchi. Compounds of biguanide with bivalent metals, copper biguanidine and its salts, III, 37.
Rây, P. R., N. K. Dutt, and T. C. Sarkar. Estimation of zinc in presence of copper, silver and mercury by means of quinaldinic acid, III, 100.
Ray, R. C., and P. B. Ganguly. Diffusion analysis of sodium silicate solutions, III, 52.
Ray, R. C., and P. C. Sinha. On the potassium salt of a new borohydrate, III, 38.
Raychaudhuri, S. P., and A. B. Nandy. Influence of saturation with lime at *p*H 7·1 on some general physical properties of lateritic soils in relation to the keen-Raczkowski box experiment, III, 185.
——— ——— Studies on base-exchange reactions and lime-requirements of some Indian lateritic soils, III, 185.
Raychaudhuri, S. P. On the nature of the red soils of Chota Nagpur Range and of Orissa, III, 185.
Raychowdhury, B. *See* Basu, K. P., M. N. Basak, and B. Raychowdhury.
Razdon, (Dr.) P., IV, 55.
Razdon, P. Colour memory—an experimental study, III, 220.
Reception Committee—Local, I, 27.
Recorders of Sections, I, 3.
Recurrent—On an Algebraic identity and a unit, III, 5.
Recurrents—Factorable—On a pair of, III, 4.
Red ochre deposits in the Punjab, III, 103.
Reddy, D. V. S. Comfort in our trains (Kata thermometer readings between Madras and Waltair), III, 205.
——— Medicine in India in the middle of 16th century, III, 169.
Relationship between upper wind velocity and temperature, III, 15.
Religious experiences of Muhammad, III, 229.
Religious Phenomena—Factors determining Changes in, IV, 55.
Resonance reactions. Part II, III, 38.
Revival of certain forgotten mineral industries, II, 89.
Rhinœstrus purpureus (Brauer, 1858) in India—The occurrence of equine nasal bot, IV, 8.
Rhythm in Modern Bengali, IV, 10.
Rinderpest in sheep and goats, III, 178.
Rinderpest in sheep and goats in the Province of Bombay, IV, 8.
Rinderpest in sheep in India, III, 179.
Ring deposits due to bombardment by positive rays, III, 26.

Roonwal, M. L. Sex ratios of the desert locust, *Schistocerca gregaria* Forsk. in the solitary phase along the Baluchistan Coast during the years, 1932–1937, III, 138.

Rothenheim, C. A., and S. S. Cowalagi. The use of tannic acid in burn, III, 168.

Rotter's test in field investigations in the determination of vitamin C deficiency—Applicability of, III, 214.

Rottlerin. Part IV, III, 64.

Roy, A. K. On forecasting of weather over south Bengal during the nor'wester season, mid-March to mid-May, III, 18.

Roy, B. C. *See* Ghosh, S. S., S. K. Roy, and B. C. Roy.

Roy, C. R. Substratum of Mediterranean element among the tribes of Sind and Baluchistan, III, 149.

Roy, D. N. *See* Banerjee, H. C., D. N. Roy, and T. P. Bhowmik.

Roy, K. L. A rapid and simultaneous method of determining nitrogen and sulphur in coal, III, 98.

Roy, S. C. The cultural national outlook, III, 153.

Roy, S. K., III, 103.

Roy, S. K. Conservation of India's Mineral Wealth, II, 65.

Roy, S. K. *See* Ghosh, S. S., S. K. Roy, and B. C. Roy.

Roy, (Mr.) S. N., IV, 16.

Roy, S. N. *See* Bose, R. C., and S. N. Roy.

Rules and Regulations, Indian Science Congress Association, I, 40.

Ryburn, (Mr.) W. M., IV, 52.

Ryburn, W. M. The psychological basis of creative work in school, III, 224.

S

Sabnis, C. V., and B. N. Banerjee. Insoluble ash of cereals and its effect on nutrition, III, 164.

Saboor, M. A. *See* Ram, Atma, M. A. Saboor, and Lal C. Verman.

Saboor, M. A., S. V. Anantakrishnan, and Lal C. Verman. Examination and classification of siliceous and felsphathic materials of Indian origin for glass manufacture, III, 87.

Sadasivan, T. S. *See* Das Gupta, S. N., and T. S. Sadasivan.

Sahariya, G. S. *See* Ahmad, Nazir, R. D. Desai, and G. S. Sahariya.

Sahariya, G. S. *See* Desai, R. D., and G. S. Sahariya.

Sahariya, G. S. *See* Desai, R. D., R. F. Hunter, and G. S. Sahariya.

Saigal, R. L. *See* Sarin, J. L., and R. L. Saigal.

Saksena, R. N. Caste and credit in rural society, III, 155.

——— Dynamics of caste, III, 154.

Salivary enzymes on cloth—Note on the duration of the activity of, III, 208.

Samanta, M. *See* Agarwalla, D., and M. Samanta.

Samanta, M. The way of sublimation, III, 229.

Samantarai, B. *See* Parija, P., and B. Samantarai.

Saminulla, M., and T. S. Wheeler. Ring closure of $\alpha\gamma$-diarylbutyric acids, III, 64.

Samuel, C. K. The life-history of the 'stilt bug' *Metacanthus pulchellus* Dallas, with a note on the immature stages of Beritidæ (Neididæ)—Hemiptera—Heteroptera, III, 146.

Sanjivarao, R., and S. G. Krishnamurty. The higher spark-spectra of iodine I(VI) and I(VII), III, 21.

Sankaran, D. K. *See* Guha, P. C., and D. K. Sankaran.

Sankaran, G. *See* Narasimharao, M., and G. Sankaran; also Mitra, D. D., and G. Sankaran.

Sant, G. K. An estimation of error from unreplicated experiments, III, 198.

Sant, G. K. *See* Tambe, G. C., and G. K. Sant; also Singh, Shamsher, and G. K. Sant.

Sarcar, D. C. Effect of temperature and humidity on cocoon production of silk-worm, *Bombyx mori* L, III, 144.

Sarin, J. L., and K. K. Nijhawan. Red ochre deposits in the Punjab, III, 103.

———— ———— Some Punjab clays, III, 103.

———— ———— Studies into the suitability of some Northern India quartzites for the manufacture of silica bricks, III, 86.

Sarin, J. L., and M. L. Beri. Some Northern India essential oils, III, 93.

Sarin, J. L., and R. L. Saigal. Physical and chemical properties of water cultrop starch, III, 93.

Sarin, J. L., and S. L. Kapur. Constituents of gram germ oil, III, 93.

Sarkar, H. L. *See* Raichoudhury, D. P., and H. L. Sarkar; also Pal, S. B., and H. L. Sarkar.

Sarkar, J. K. *See* Chatterjee, H. N., and J. K. Sarkar.

Sarkar, P. B., III, 37.

Sarkar, P. B. Analogy among chemical elements and radicles, II, 45.

Sarkar, T. C. *See* Rây, P. R., N. K. Dutt, and T. C. Sarkar.

Sarma, R. S. M. Psychological investigation of insane murders, III, 227.

Sarna, H. R. Dielectric constants of certain liquids with special reference to dispersion at audio frequencies, III, 29.

Sarna, (Dr.) H. R., IV, 14.

Sapra, A. N. Experiments on the summer control of Plant Mites, III, 197.

Sapre, S. N. A technique for cutting serial sections of chitinous objects, III, 174.

———— *Ornithodorus crossi*, Brumpt, 1921, as a valid species and not a synonym of *Ornithodorus papillipes*, Birula, 1895, III, 174.

Sarwar, M. S. Damage to wheat, sugar-cane, maize and fruit trees by termites in the Punjab, III, 144.

———— New species of termites recorded in the Punjab, III, 144.

———— New sub-genus of the genus *Microtermes*, III, 144.

———— New wood-destroying species of termites in the Punjab, III, 144.

———— Taxonomic value of the structure of mandibles of workers in termites, III, 144.

Sastri, B. N. *See* Ganapathy, C. V., and B. N. Sastri.

Sastri, M. V. C., and K. R. Krishnaswami. The relative activities of samples of adsorbent charcoal as determined by different methods, III, 49.

Sastry, (Mr.) N. S. N., IV, 23.

Sastry, N. S. N. An experiment on æsthetic value, III, 221.

Satakopan, V. *See* Ramdas, L. A., V. Satakopan, and S. Gopal Rao.

Satyanand, D. Chemiotherapy of Schizophrenia, III, 228.

Sayeedud Din, M. Systematic anatomy of *Sesamum laciniatum* Klein. with special reference to its mucilage glands, III, 125.

Schizophrenia—Chemiotherapy of, III, 228.

Schizophrenia—Modern treatment of, III, 227.

Sebastian, V. O. Development of *Herdmania pallida*, III, 132.

Secretaries—Honorary General, I, 5.

Secretaries—Joint Local, I, 12.

Secretaries—Local Sectional, I, 4.

Secretary—Honorary Managing, I, 5.

Secretary—Local, I, 12.

Sections—Resolutions adopted by, I, 39.

Seed-borne Diseases—Application of solar heat for control of, IV, 30.

Self-reciprocal functions—On certain, III, 2.

Selzer, H. M. Modern treatment of Schizophrenia, III, 227.

———— Therapeutical indications of frigidity in women, III, 228.

Semi-diurnal winds at St. Helena, II, 26.

Sen, A. C. *See* Sen, Amalesh C., and A. C. Sen.

Sen, Amalesh C., and A. C. Sen. Rhythm in Modern Bengali, IV, 10.

Sen, Bibhutibhusan. Some boundary value problems of the theory of elasticity, III, 6.

Sen, D. Prehistoric rock carvings, III, 154.

Sen, D. N., and R. Mahanty. Generalizations on partial fractions in determinantal forms, III, 4.

Sen, D. N., and V. Rangachariar. On sphero-tangential equation of a surface, III, 4.

Sen, H. K., M. Venugopalan, and S. C. De. Unsaturation in shellac, III, 84.

Sen, H. K. *See* Bhattacharya, G. N., and H. K. Sen.

Sen, H. K. *See* Rangaswami, M., and H. K. Sen; also Ranganathan, S., and H. K. Sen.

Sen, H. K. *See* Venugopalan, M., and H. K. Sen.

Sen, (Dr.) Indra, IV, 54.

Sen, Indra. Contributions of Abnormal to Normal Psychology, III, 223.

Sen, (Mr.) J. M., IV, 54.

Sen, J. M. Psychology of the New Education Movement, III, 224.

Sen, K. C., and N. K. Ayyar. Deficiency diseases of animals in India, III, 177.

Sen, N. R. On the gravitational influence of radiation on radiation, III, 12.

Sen, (Mr.) P., IV, 33.

Sen, P. Breeding habits of *Anopheles sundaiens Rodenov*, IV, 6.

Sen, S. K. The possibilities of cattle fly sprays in India, III, 174.

Sen Gupta, N. C. The yield value of thixotropic bentonite suspensions, III, 52.

Sen Gupta, (Dr.) N. N., IV, 24, 55.

Sen Gupta, N. N. An experimental study of the difference between lines visually apprehended and lines drawn, III, 220.

——— Mental diseases among the primitive people, III, 152.

——— The 'Shaman' personality: a psychological evaluation, III, 151.

——— Towards a dynamic theory of space-perception, III, 219.

Sensation, Perception and Memory, III, 219.

Sentiments—A reconstruction of the hormic theory of, III, 222.

Septicæmic plague—A study of the blood picture in, III, 160.

Serology in Radiation Therapy, IV, 7.

Serum phosphatase activity in rats fed with different diets, III, 165.

Seshachar, B. R. The chromosomes of *Ureotyphlus menoni* (Annandale), III, 137.

Seshadrinathan, N., and D. R. Annamalai. A study of the blood picture in septicæmic plague, III, 160.

Seth, A. C. *See* Dasannacharya, B., and A. C. Seth.

Seth, B. R. Some problems of finite strain, III, 6.

——— Uniform motion of a sphere or a cylinder through a viscous liquid, III, 6.

Seth, J. B. Rainfall in the Punjab, III, 17.

Sethna, S. M., and R. C. Shah. Condensation of methyl β-resorcylate with ethyl acetone dicarboxylate and ethyl α-chloroacetoacetate, III, 61.

Sex and family—Taboo and discipline of, III, 151.

Sex in plantain flowers—Determination of, III, 120.

Shah, B., and K. R. Krishnaswami. Estimation of gold in cyanide solutions, III, 99.

Shah, H. A., and R. C. Shah. γ-substitution in the resorcinol nucleus. Part III. Synthesis of 2 : 6-dihydroxy 3-ethyl benzaldehyde, III, 67.

——— γ-substitution in the resorcinol nucleus. Part IV, III, 67.

Shah, N. M. *See* Kulkarni, D. R., N. M. Shah, and R. L. Alimchandani.

Shah, R. C. *See* Shah, H. A., and R. C. Shah.

Shah, R. C. *See* Sethna, S. M., and R. C. Shah.

Shah, S. M. On integral functions of finite order, III, 3.
Shah, S. V. *See* Airan, J. I., and S. V. Shah.
Sharma, D. L. Relation of thought and language, IV, 11.
Sharma, N. L. Royite, a new mineral, from the Jharia coal-field, III, 104.
Sharma, Parmanand, and L. N. Srivastava. A magnetic investigation of the photohalides of silver, III, 33.
Sharma, Parmanand. *See* Srivastava, L. N., and Parmanand Sharma.
Shastri, T. P. Bhaskara. A survey of stars with large proper motion in the Hyderabad Astrographic zones, III, 10.
——— Some photographs of regions in the Milky Way, taken with a short focus camera, III, 10.
Shenoi, R. B., and T. S. Wheeler. Enolization of diaroylmethanes, III, 69.
Shirlaw, J. F. 'Deg Nala' disease of buffaloes—an account of the lesions and essential pathology, III, 170.
Shoots in sugarcane—Seasonal, IV, 9.
Shourie, K. L. A survey of diet and nutrition in Najafgarh, Delhi Province, III, 164.
Shourie, K. L. *See* Giri, K. V., K. L. Shourie, and K. Rajagopal.
Shrimali, (Mr.) K. L., IV, 54.
Shrimali, K. L. A study of the free drawings of an eight year old child, III, 232.
Shroff, H. P. *See* Desai, R. D., Ashraff Ali, and H. P. Shroff.
Siddiqi, M. Raziuddin. Further contributions to the theory of non-linear integral equations, III, 1.
Silicic acid sol with concentrated alkalis—The interaction of, III, 52.
Silk-worm, *Bombyx mori* L—Effect of temperature and humidity on cocoon production of, III, 144.
Silk-worm—Effect of variable temperature and humidity upon different varieties of, III, 145.
Silk-worm, *Bombyx mori* L—On the nervous system of, III, 145.
Silk-worm, *Bombyx mori* L—On the reproductive system of the, III, 145.
Sind—Potential spas of, III, 112.
Singh, B. K. The space configuration of nitrogen in the 3-covalent state, III, 58.
Singh, B. N. *See* Kothari, D. S., and B. N. Singh.
Singh, D. B., and K. C. Pandya. Condensation of *o*-, *m*- and *p*-nitrobenzaldehydes with malonic acid in the presence of organic bases, III, 61.
Singh, Darshan, and Nek Alam. A new and simple contrivance for pohli (Carthamus Oxyacantha) eradication called 'Darshan Pohli Maru Datri', III, 191.
——— ——— Darshan-Alam set of hoes and cultivators, III, 202.
Singh, Jagdish. A psychological interpretation of the primitive pubescent ceremonies, III, 232.
Singh, Kr. Indrajit, and D. N. Majumdar. The Murias of Narayanpur, Bastar State, III, 155.
Singh, Mohan. *See* Kehar, N. D., and Mohan Singh.
Singh, Narain. *See* Anand, B. M., and Narain Singh.
Singh, Shamsher, and G. K. Sant. Shedding of buds, flowers and bolls of cotton in relation to environment and cultural factors, III, 190.
Sinha, P. C. *See* Ray, R. C., and P. C. Sinha.
Sinha, S. A wet rot of leaves of *Colocasia antiquorum* due to secondary infection by *Blakslea trispora* and *Choanephora cucurbitarum* (B. and Rav.) Thaxter, III, 116.
——— On the characters of *Choanephora cucurbitarum* (B. and Rav.) Thaxter, causing a wet rot of chillies, III, 115.
Sinha, S. *See* Das Gupta, S. N., and S. Sinha.
Sinha, T. C. Attempt at interpretation of a Garo dream, III, 228.

Sircar, A. C., and A. K. Guha. Attempts to prepare azine and azonium dyes from isatin, III, 83.
Sircar, S. M. A study on the rate of respiration in relation to nitrogen metabolism of potato tuber, III, 125.
——— Phosphorus nutrition of wheat, III, 125.
Sirdar, J. N. *See* Bagchi, K. N., H. D. Ganguly, and J. N. Sirdar.
'Social-affective' Concept of meaning—The, III, 223.
Social Disorganisation, IV, 24.
Social Disorganisation—Rôle of Individual in, IV, 24.
Societies—Scientific, I, 19.
Society—Personality structure and, II, 359.
Sodhi, T. S. *See* Pandya, K. C., and T. S. Sodhi.
Sodium atoms in absorption—Note on a change in the transition probability of, III, 20.
Sodium chlorate from brine mixtures—Electrolytic formation of, III, 40.
Sohi, G. S. *See* Husain, M. Afzal, and G. S. Sohi.
Soil erosion in India, IV, 37.
Soil fertility, Part II—Studies in, III, 187.
Soil fertility, Part III—Studies in, III, 187.
Soils, Fertilizers and Manures, III, 184.
Solanki, D. N. *See* Joshi, S. S., and D. N. Solanki.
Solar diurnal variation—Diamagnetic and drift-current theories of, II, 30.
Solar diurnal variations of the earth's magnetic field and their analysis—The, II, 22.
Solar diurnal variation—The conductivity of the upper atmospheric layers responsible for the, II, 28.
Solar diurnal variation layer—The level of the, II, 28.
Soni, B. N. Further observations on the bionomics of the ox warble-fly (*Hypoderma lineatum*) in India, III, 173.
——— Studies upon the morphology of the larval forms of *Hypoderma crossii*, III, 176.
South India—The tanning industry in, III, 113.
Space-perception—Towards a dynamic theory of, III, 219.
Spark-spectra of iodine I(V)—The higher, III, 21.
Spark-spectra of iodine I(VI) and I(VII)—The higher, III, 21.
Spectra of antimony in a hot hollow cathode—Production of the, III, 22.
Spectra of some salts of alkaline earths—Flame, III, 23.
Spectroscopic determination of the amount of ozone in the atmosphere over Bombay, III, 14.
Spectrum of copper bromide—The flame, III, 23.
Sphero-tangential equation of a surface—On, III, 4.
Spiral nebula—The arms of a, III, 11.
Sreenivasan, (Dr.) A, IV, 43.
Sreenivasaya, M., and A. Venkatasubban. Separation of lac into sclerolac and soft lac, III, 90.
Sreenivasaya, M., and K. Linderstrom-Lang. Micro-determination of the kinetics of tyrosine-tyrosinase action, III, 98.
Sreenivasaya, M., and N. W. Pirie. The disintegration of tobacco mosaic virus preparations with sodium dodecyl sulphate, III, 97.
Sreenivasaya, M. *See* Venkatasubban, A., and M. Sreenivasaya.
Sreenivasaya, M. *See* Venkatasubban, A., M. V. Kesava Rao, and M. Sreenivasaya.
Srinivasan, K. *See* Joshi, S. S., and K. Srinivasan.
Srinivasan, M. K., and B. Prasad. Viscosity and density of aqueous solutions of sulphuric acid at 35°C., III, 58.
Srinivasan, V. K. Morphological and cytological studies in Scropulariaceæ, III, 123.
Srivastava, L. N., and Parmanand Sharma. Magneto-chemical investigation of the photohalides of silver, III, 45.
Srivastava, L. N. Reaction of sodium thiosulphate and organic acids in the solid state, III, 38.

Srivastava, L. N. *See* Sharma, Parmanand, and L. N. Srivastava.
Srivastava, T. N. *See* Pande, S. K., and T. N. Srivastava.
Staphylococcus aureus in vaccine lymph, III, 163.
Statement of Accounts, I, 49.
Static Geography of India, II, 100.
Statistical methods, III, 197.
Stereochemistry of pinane and its derivatives—The, III, 60.
Stewart, R. R. The flora of Mussoorie, III, 126.
Storage at different relative humidities on the strength and colour of cotton—The effect of, III, 29.
Storms—Magnetic, II, 33.
Strain—Finite—Some problems of, III, 6.
Stratigraphy and palæontology, III, 107.
Streptococci associated with strangles in India—Biochemical classification of, III, 172.
Structure of Liquids—The, IV, 13.
Structure-sensitiveness and the Temperature-dependence of the abnormal unidirectional diamagnetism of graphite crystal—The, IV, 3.
Subbaiah, V. C. *See* Joshi, S. S., and V. C. Subbaiah.
Subbaiya, M. Sampling in sugarcane experimental work, III, 197.
Subbaraman, P. R., and K. R. Krishnaswami. Adsorption and retention of helium by cocoanut shell charcoal, III, 49.
Sub-clinical Vitamin A deficiency studied by a photometer, III, 211.
Sublimation—The way to, III, 229.
Subrahmaniam, (Mr.) M., IV, 17.
Subramaniam, T. V. Sugarcane borers and their control in the Mysore State, III, 190.
Subramanian, K. *See* Varma, P. S., and K. Subramanian.
Subramanian, K. S. *See* Guha, P. C., and K. S. Subramanian.
Subrahmanyam, N., III, 109.
Subramanya, T., and S. K. K. Jatkar. Esterification equilibria in vapour phase, III, 55.
Subrahmanyam, (Mr.) N., IV, 16, 18, 19.
Subrahmanyam, N. The Geographical Personality of India, II, 99.
Sugar-acid-pectin relationship in the stabilization of fruit juices, III, 96.
Sugarcane borers and their control in the Mysore State, III, 190.
Sugarcane cultivation in India, III, 111.
Sugarcane experimental work—Sampling in, III, 197.
Sugarcane in different types of soil under field conditions—Root studies of, III, 188.
Sukthankar, S. S., N. Ahmad, and H. Nawkal. A self-recording apparatus for determination of fibre-strength, III, 30.
Sulaiman, Sir Shah. Levi-Civita's potential function for two bodies, III, 10.
Summer control of plant mites—Experiments on the, III, 197.
Sundaresan, K. The Cheyyar basin, III, 113.
Sun-spot line at λ6708A.—On the identification of the, III, 20.
Sunthankar, S. R. *See* Jatkar, S. K. K., and S. R. Sunthankar.
Surgery, III, 167.
Symbiosis and acculturation, II, 218.
Symposia and joint meetings, I, 15.
Systolic blood pressure in healthy young students—Range of, III, 205.

T

Taher, N. A. The rates of reaction of *p*-alkyl benzhydryl chlorides with ethyl alcohol, III, 54.
Talpade, C. R. *See* Prasad, Mata, and C. R. Talpade.
Talwar, A. S. Life-history of *Plerochlorus persicae* (peach-sten aphid), III, 140.

Tambe, G. C., and G. K. Sant. Crop response to winter cultivation in Malwa, III, 184.
Tamil Nad—The floods of 1937 in the, III, 113.
Tamil region—The traditional limits and sub-divisions of the, III, 113.
Tannic acid in burn—The use of, III, 168.
Tanning industry in South India—The, III, 113.
Tawde, N. R., and V. D. Desai. First positive bands in high temperature arc, III, 23.
Tawde, N. R., Y. G. Naik, and V. D. Desai. Variation of the relative infra-red content of the solar radiations at Bombay, III, 23.
Taxonomic studies of Indian smuts, III, 115.
Taxonomy, III, 128.
Taylor, (Dr.) McKenzie, IV, 36.
Teacher and his make-up, IV, 11.
Technical Physics and General Properties of Matter, III, 29.
Temperature coefficient of conductivity of an aq. solution of iodic acid, III, 45.
Temperature coefficients of electrical conductivity and viscosity of aqueous mercuric chloride at different temperatures—The, III, 45.
Temperature variation of the magnetic anisotropy of $CuSO_4$ $5H_2O$, IV, 3.
Termites in the Punjab—Damage to wheat, sugar-cane, maize and fruit trees by, III, 144.
Termites recorded in the Punjab—New species of, III, 144.
Termites—Taxonomic value of the structure of mandibles of workers in, III, 144.
Thackar, V. C. *See* Prasad, Mata, M. R. Kapadia, and V. C. Thackar.
Thakur, A. K. Action of ammonia gas on lac, III, 87.
Theoretical statistics, IV, 14.
Therapeutical indications of frigidity in women, III, 228.
Thermal repulsion of particles—Some experiments on the, III, 33.
Thermal structure of the air layers near the ground at night during clear weather in relation to other meteorological factors—The, III, 19.
Thirunaranan, B. M., and V. E. Naganatha Rao. The floods of 1937 in the Tamil Nad, III, 113.
Thirunaranan, B. M. The traditional limits and sub-divisions of the Tamil region, III, 113.
Thosar, V. B. *See* Mehta, T. N., and V. B. Thosar.
Thought and language—Relation of, IV, 11.
Tirumurti, (Rao Bahadur) T. S., III, 157.
Tirumurti, (Rao Bahadur) T. S. A brief account of the history of pathology, II, 225.
Tirumurti, T. S., and K. Narayana Murthi. A preliminary report on the possible etiological factor in the causation of infantile biliary cirrhosis being found in castor oil, III, 157.
Tissue culture—its application in Medical and biological researches, IV, 9.
Tiwary, N. K. Observations on the pollination, and the phenomena connected with it in *Eugenia jambolana*, III, 124.
Tolerance of different types of cotton to alkaline soils in Sind—Note on the, III, 181.
Totemism in Ancient India, III, 152.
Toxicology, III, 166.
Toxicology of *Execaria agallocha* and difficulties in the way of medico-legal investigations—Studies on, III, 167.
Transpiration in relation to metecrological factors—A study of, III, 201.
Transpiration of a leaf from the earliest stage to its fall—March of, III, 126.
Treasurer—Honorary, I, 5.
Treatment of Schizophrenia—Modern, III, 227.
Trehan, (Dr.) K. N., IV, 34.
Trematode fauna of India—A brief survey of the development of the knowledge of, III, 130.

Tremolite marbles from Singareni, Warangal District (Hyderabad), III, 107.
Tribal cultures and acculturation, II, 179.
Tripathi, Gopal. *See* Joshi, S. S., and Gopal Tripathi.
Triple integration—On an interpolation formula for, III, 4.
Trivedi, D. M. *See* Mehta, T. N., and D. M. Trivedi.
Trivedi, H., and Lal C. Verman. Some problems in tinning of articles of complicated shapes and contours, III, 87.
Trivedi, H. *See* Verman, Lal C., N. Ghatak, and H. Trivedi; also Verman, Lal C., H. Trivedi, and N. Ghatak.
Trivedi, R. K. *See* Naik, K. G., R. K. Trivedi, and H. P. Parikh.
Trogoderma khapra adults—Light reactions of, III, 196.
Trombidiid larva parasitic on the house rat (*Rattus rattus* var.)—On a new, III, 173.
Tungsten filament electric lamps—The maximum efficiency of, III, 32.

U

Uppal, I. S., and K. Venkataraman. The sulphonation of monoethylaniline, III, 71.
Uppal, I. S., and K. Venkataraman. Wetting agents. Part IV. Further derivatives of arylamine sulphonic acids, III, 84.
Upper Atmosphere—The Earth's Magnetism and the, II, 19.
Upper atmospheric current system and its location in the atmosphere—Cause of, II, 26.
Upper wind velocity and temperature—Relationship between, III, 15.
Urea-stibamine on frog's heart—The effects of some ions on the action of, III, 216.

V

Vaidhianathan, (Dr.) V. I., IV, 41.
Vaidya, B. K. Flame spectra of some salts of alkaline earths, III, 23.
Vaidya, B. K. *See* Desai, C. M., and B. K. Vaidya.
Vaidyanathaswamy, R. The application of group-characters for the determination of normal modes, III, 1.
Vakil, (Miss) V. M. *See* Desai, R. D., and (Miss) V. M. Vakil.
Valvekar, R. K. *See* Jatkar, S. K. K., and R. K. Valvekar.
Varadarajan, S. *See* Devanesan, D. W., and S. Varadarajan.
Varahalu, T. *See* Ramiah, P. V., and T. Varahalu.
Variability of plant density and the estimation of yield of cotton by sampling, III, 198.
Varma, P. S., and K. S. Venkat Raman. Synthesis of methoxy and ethoxy phenarsazines, III, 82.
Varma, P. S., and K. Subramanian. Halogenation. Part XXIV. Halogenation of acenaphthene, III, 73.
Varma, P. S., and S. Srinivas Rao. Halogenation. Part XXIII. Halogenation of 2 : 6 dimethylnaphthalene, III, 73.
Varma, R. S. A pair of functions which are Hankel transforms of each other, III, 2.
——— Some infinite series involving the product of Bessel functions and Weber's parabolic cylinder functions, III, 2.
Vegetable oils—Cracking of. Part I. Groundnut oil, III, 92.
——— ——— Part II. Mowrah oil, III, 92.
——— Utilization of Indian. Iodized oils, III, 92.
Venkatachari, T. P. Geography of the Casuarina plant, III, 114.
Venkataraman, K. *See* Desai, M. B., and K. Venkataraman; also Forster, R. B., R. C. Gandhi, and Venkataraman.
Venkataraman, K. *See* Ramachandran, S. R., and K. Venkataraman.
Venkataraman, K. *See* Uppal, I. S., and K. Venkataraman.
Venkataraman, K. *See* Uppal, I. S., and K. Venkataraman; also Bhat, R. V., R. B. Forster, and K. Venkataraman.

Venkataraman, K. S. Geographical personality of Coorg, III, 114.
Venkataramanan, K. *See* Raghavachari, T. N. S., and K. Venkataramanan.
Venkatarayudu, T. Raman spectra and the structures of PCl_5 and $SbCl_5$, III, 28.
Venkatasubban, A., and M. Sreenivasaya. Utilization of lac dust or Molamma, III, 90.
Venkatasubban, A., M. V. Kesava Rao, and M. Sreenivasaya. Dielectric strength of lacs of known origin, III, 90.
Venkatasubban, A. *See* Sreenivasaya, M., and A. Venkatasubban.
Venkitasubban, C. S., and A. Neelakanta Iyer. Biological notes on insect pests of young graft mango plants in Cochin, III, 193.
Venkitasubban, C. S. Trials with the insectide from 'Derris elliptica' plant cultivated in Cochin, III, 193.
Venugopalan, M., and H. K. Sen. Condensation of shellac and shellac acids with alcohols, aldehydes, acids and acid anhydrides, III, 88.
—— —— Modification of shellac with aniline and formaldehyde, III, 89.
—— —— Modifications of the soft resin from shellac, III, 89.
Venugopalan, M. *See* Sen, H. K., M. Venugopalan, and S. C. De.
Verma, G. S. A new species of *Bombardia* occurring on dry twigs of *Thunbergia grandiflora* Roxb., III, 115.
Verma, (Mr.) P. M., IV, 32.
Verman, Lal C., H. Trivedi, and N. Ghatak. Accelerated weathering of paints and the development of a weatherometer suitable for tropical climates, III, 31.
Verman, Lal C., N. Ghatak, and H. Trivedi. Natural weathering of paints and some considerations entering the technique of testing their durability, III, 30.
Verman, Lal C. *See* Banerji, A. D., C. A. Khan, and Lal C. Verman; also Joglekar, G. D.; also Karim, S. Mujtaba, Lal C. Verman, and S. V. Anantakrishnan.
Verman, Lal C. *See* Joglekar, G. D., K. Subba Ramaiah, D. S. Naidu, and Lal C. Verman; also Saboor, M. A., S. V. Anantakrishnan, and Lal C. Verman.
Verman, Lal C. *See* Karimullah, N. Ghatak, J. S. Aggarwal, and Lal C. Verman.
Verman, Lal C. *See* Ram, Atma, M. A. Saboor, and Lal C. Verman; also Ghatak, N., and Lal C. Verman.
Verman, Lal C. *See* Trivedi, H., and Lal C. Verman.
Vertical currents in the first few kilometers over Poona and their possible effect on the measures of upper winds made by pilot balloons assumed to rise at a known constant rate, III, 19.
Veterinary Research, III, 170.
Veterinary Research—Section of Medical and, III, 157.
Vice-Chairman, I, 12.
Vice-Patron, I, 3.
Vidyarthi, N. L., and M. Narasinga Rao. Cane wax I. Non-saponifiable matter of the wax, III, 75.
—— —— Cane wax II. Composition and constitution of the fatty-acids of the wax, III, 75.
Vidyarthi, N. L. *See* Rao, C. J. Dasa, and N. L. Vidyarthi.
Virkar, V. V., and T. S. Wheeler. 2-naphthyl-chromones, III, 63.
Virus, III, 178.
Visceral gout of fowls in India, III, 170.
Viscosity and density of aqueous solutions of sulphuric acid at 35°C., III, 58.
Viscosity of colloids—Influence of electric fields on the, III, 50.
Viscosity of shellac-urea solutions in alcohol—The effect of ageing on the, III, 58.
Visits and excursions, I, 18.

Visual image in tactual localization—The importance of, III, 219.
Visual perception of geometrical figure in indirect vision, III, 219.
Visvanathan, K. S. *See* Joshi, S. S., and K. S. Visvanathan.
Vitamin A and C changes in the mangoes during ripening, III, 95.
Vitamin B-complex in toxic conditions—The, III, 212.
Vitamin C and tissue phosphatases—Interaction of, III, 166.
Vitamin C of Bengali boys—Observations on the minimum requirements of, III, 213.
Vitaminosis, III, 177.
Vocational guidance—Problems and difficulties of, III, 225.
Voluntary muscle—Histological chemistry of, III, 210.

W

Wad, (Mr.) Y. D., IV, 39, 42.
Weather over south Bengal during the nor'wester season, mid-March to mid-May—On forecasting of, III, 18.
Weathering of paints and some considerations entering the technique of testing their durability—Natural, III, 30.
Weathering of paints and the development of a weatherometer suitable for tropical climates—Accelerated, III, 31.
Weber's parabolic cylinder functions—Some infinite series involving the product of Bessel functions and, III, 2.
Wheat—Phosphorus nutrition of, III, 125.
Wheeler, T. S. *See* Acharya, B. G. S., and T. S. Wheeler; also Virkar, V. V., and T. S. Wheeler; also Saimulla, M., and T. S. Wheeler; also Kamat, R. K., and T. S. Wheeler.
Wheeler, T. S. *See* Bhagwat, N. A., and T. S. Wheeler.
Wheeler, T. S. *See* Panse, T. B., and T. S. Wheeler; also Shenoi, R. B., and T. S. Wheeler.
White dawrf stars and the planets—The internal constitution of, III, 13.

X

X-radiation—A study of the energy distribution of scattered, IV, 2.
X-rays—A study on the polarisation of, IV, 2.
X-rays—Absorbability of scattered, IV, 1.

Z

Zachariah, (Miss) A. T. *See* Das Gupta, S. N., and (Miss) A. T. Zachariah.
Zakaria, Majid. Categories and concepts in Psychology, III, 223.
Zakiuddin, M. Thermal properties of films of liquid Helium II, III, 33.
——— Transfer of liquid Helium II, III, 34.
Zoögeography of India, IV, 20.
Zoology—Section of, II, 169 ; III, 129.

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Date of issue.	Date of issue.	Date of issue.
18.8.44	2-70	ILL
25.10.45		5/5/95
12.11.45		
13.5.46	30/7/96	for a
13.8.49		day
3.3.53		
20.11.59		
21.2.1961		
11/1/61		
3.2.64		
21-7-64		
10 NOV 1986		